CRS20 Operator's Manual

BCRAIL

RAIL OPERATIONS

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Publication Notice

This manual is designed to explain how operators should use basic locomotive equipment. When special equipment is involved, consult the specific instructions and drawings provided by the Railway.

The information contained here is based on data available at the time of printing.

Note:

The CRS20 Locomotive is equipped with Autostart. The locomotive must be conditioned for Autostart when it is not in use with the hand brake applied.

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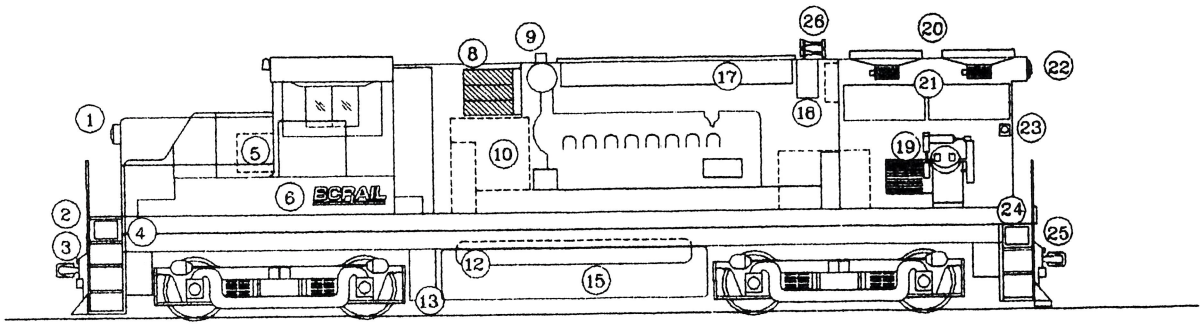
Introduction

This manual has been prepared for BC Rail personnel who operate the 2000 H.P. Caterpillar diesel-electric locomotive produced at the BC Rail Squamish Motive Power complex. It describes the locomotive and explains its operations.

1. **General Data** lists the specifications of the locomotive and its components.
2. **Overview** describes principal equipment and components.
3. **Cab Controls and Indicating Devices** explains the function and operating features of controls used to start, operate and shutdown the locomotive. It also describes the indicating devices used to monitor certain locomotive systems. It shows the location of each control and device in pictures and diagrams.
4. **Engine Room Controls** explains the location, function and operating features of electrical and mechanical equipment in the engine room.
5. **Operation** outlines procedures for operating the locomotive.

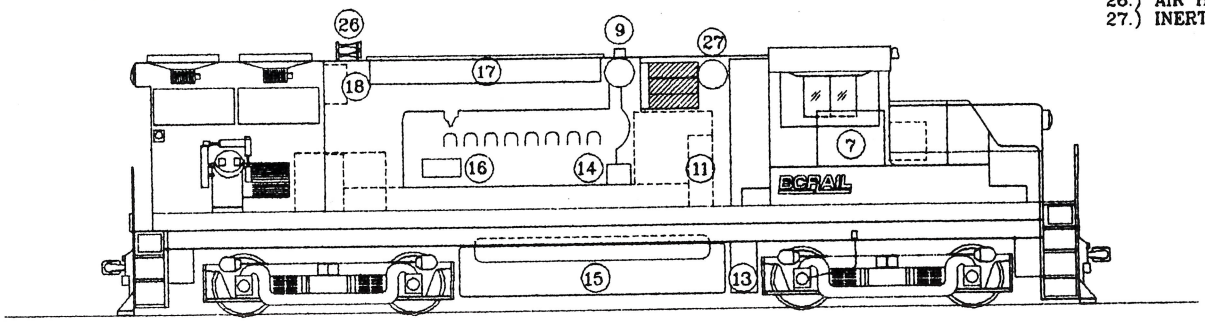
6. **Troubleshooting** describes the probable causes of operating trouble and suggested operator action.

To learn about maintaining, adjusting and testing equipment, refer to maintenance manuals for this locomotive and optional equipment.



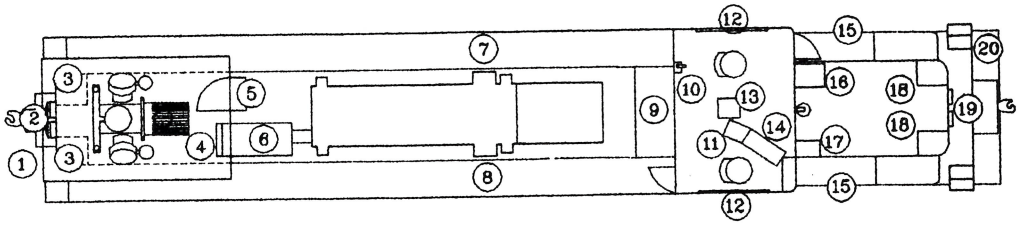
LEFT SIDE ELEVATION

1.) FRONT HEADLIGHTS
2.) SLUG POWER RECEPTACLE
3.) FRONT M.U. RECEPTACLE
4.) M.U. JUNCTION BOX
5.) RSD
6.) AIR BRAKE
7.) CONTROL CONSOLE
8.) ENGINE AIR FILTER
9.) SPARK ARRESTOR
10.) TRACTION ALTERNATOR
11.) TRACTION MOTOR BLOWER
12.) MAIN AIR RESERVOIR
13.) WASTE OIL COLLECTION TANK
14.) STARTER CABINET
15.) FUEL TANK
16.) STARK STATION, PANEL & GUAGES
17.) D.B. RESISTORS
18.) COOLANT EXPANSION TANK
19.) AIR COMPRESSOR
20.) RADIATOR COOLING FANS
21.) RADIATOR COMPARTMENT
22.) REAR HEADLIGHTS
23.) SAND FILLING
24.) M.U. JUNCTION BOX
25.) REAR M.U. RECEPTACLE
26.) AIR HORN
27.) INERTIAL BLOWER

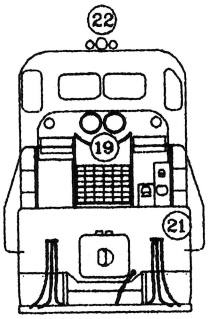


RIGHT SIDE ELEVATION

1.) REAR M.U. CONNECTION
2.) REAR HEADLIGHTS
3.) REAR SAND STORAGE
4.) AIR COMPRESSOR
5.) A.C. PANEL
6.) AUX. ALTERNATOR & GEN.
7.) ENGINE JUNCTION BOX
8.) STARTER BOX
9.) ELECTRICAL COMPARTMENT
10.) HAND BRAKE
11.) CONTROL STAND
12.) HEATER
13.) FRIDGE
14.) HOT PLATE
15.) BATTERIES
16.) ELECTRICAL CABINET HEATER
17.) RSD
18.) FRONT SAND STORAGE
19.) FRONT HEADLIGHTS
20.) FRONT M.U. JUNCTION BOX
21.) M.U. HOSES
22.) AIR HORN



PLAN



FRONT ELEVATION

General Data

Model Designation	CRS20	
Wheel Arrangement	B-B	
Locomotive Horsepower	2000	
Diesel Engine	Model	Caterpillar 3516
	Type	Turbocharged
	Number of Cylinders	16
	Cylinder Arrangement	60° "V"
	Cylinder Bore and Stroke	170mm x 190mm (7.6" x 7.5")
	Operating Principle	4 stroke cycle Turbocharged, unit injection, water cooled
	Full Speed	1800 RPM
	Idle Speed	600 RPM

Main Alternator	Traction Alternator (Rectified Output)	KATO Type-24254
	Maximum Voltage (DC)	1250
	Maximum Continuous Current (DC)	4400
Auxiliary Alternator	Voltage Rectified (DC)	74
	Nominal Capacity	15 KW
Auxiliary Alternator	Voltage (AC)	73-200
Traction Motors	Model	GE-752
	Number	4
	Type	DC, Series Wound, Axle Hung
Driving Wheels	Number	4 pair
	Diameter	4"
	Tread Profile	Heumann
	Gear Ratio	74:18
	Maximum Speed	65 MPH
Air Compressor	Type	WEBCO 3CDC 2 stage
	Number of cylinders	3

Air Compressor (cont.)	Capacity (Compressor RPM = 900, Diesel RPM = 1800)	202.5 CFM
	Air Compressor Cooling	Air
	Lube Oil Capacity	4 Gals (IMP) 18 Liters
	Air Compressor Motor	KATO 55HP A.C.
Storage Batteries	Type	Lead Acid
	Number of Cells	32
	Voltage	64
	Rating (8 hour)	425 Amp Hr.
Supplies	Lubricating Capacity	177 Gals (IMP) 805 Liters
	Cooling Water Capacity	100 Gals (IMP) 455 Liters
	Fuel Capacity (601-609)	1,200 Gals (IMP) 6,365 Liters
	(610-630)	1,600 Gals (IMP) 7,274 Liters
	Sand	40 cu. ft.
	Air Brakes	26L
	Approximate weight on drivers	250,000 lbs
	Weight on drivers	100%

Major Dimensions	Overall Width	10 ft 1 5/8 in
	Distance between coupler faces	56 ft 11 3/4 in
	Distance, pulling face of coupler to bolster centreline	12 ft 2 7/8 in
	Distance between bolster centres	31 ft
	Height, top of rail to top of horn	15 ft 5 1/2 in
Minimum curve negotiation	MU Operation	30 degrees
	Single Unit	39 degrees

Chapter 1
Overview

1.0 Locomotive Operation

BC Rail's Model CRS20 diesel-electric locomotive is equipped with a twin turbocharged, 16 cylinder, 3516 Caterpillar diesel engine that drives the main generator. High voltage electrical equipment distributes electrical power from the main generator to the traction motors. Each of the four traction motors is geared directly to a pair of driving wheels. The gear ratio of the traction motor to the wheel determines the maximum operating speed of the locomotive.

While the short hood or cab end identifies the front of the locomotive, it operates equally well in either direction.

The locomotive is designed for single unit, multiple units or slug operation. When coupled together in multiple units, the operator controls all units simultaneously, through trainline jumper cables, from the control stand in the cab of the lead unit. Slug operation is also controlled through a trainline jumper cable connected between the locomotive and slug.

1.1 Equipment and Components

Most of the components on the locomotive perform functions that relate to either the diesel engine or the transmission of electrical power to the driving wheels.

- The diesel engine is the source of locomotive power.
- Storage batteries provide the energy required to start the engine.
- The prelube pump/start switch controls battery power to two starting solenoids mounted at the lower left hand side of the engine.
- The starting solenoids engage two starting motor pinions with the engine ring gear. When both motor pinions are engaged, battery power is applied to the starting motors to crank the engine.
- Once started, all the engine power drives two electrical generators, which in turn power the cooling fans, compressor and engine support systems.

- The electrical transmission is made up of:
  - the traction alternator
  - the rectifiers
  - the direct current traction motors
  - the locomotive propulsion control system.

- The traction alternator rotates at engine speed (Fig. 1-1). It supplies high voltage AC power to rectifier assemblies which then deliver high voltage DC power to the traction motors for locomotive pulling power.

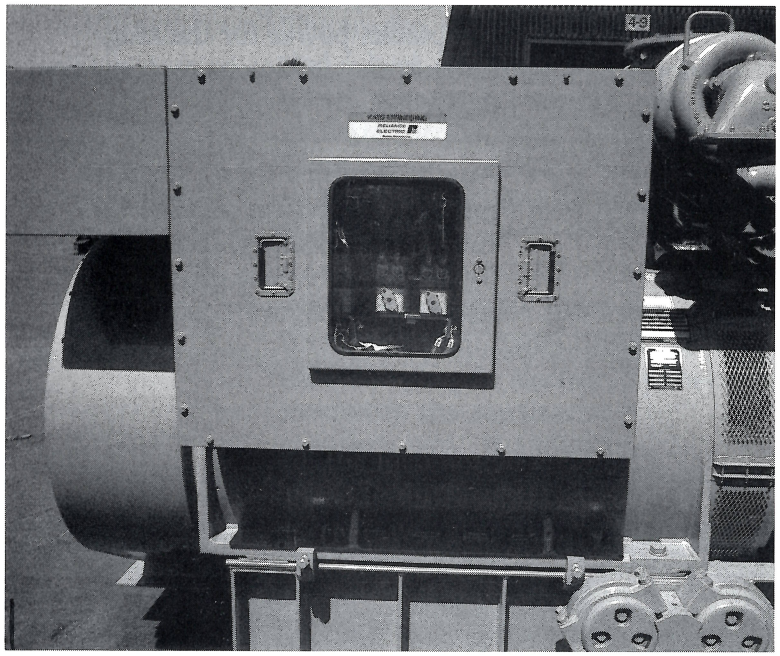


Figure 1-1: Traction Alternator

- Auxiliary alternator #1 supplies AC power to the air compressor motor, radiator fan motors, filter blower motor and, through a trainline receptacle, power for the slug traction motor blower motors. See figure 1-2.

- Auxiliary alternator #2 supplies rectified DC power needed for control, cab heating, locomotive lighting and battery charging circuits. See figure 1-2.

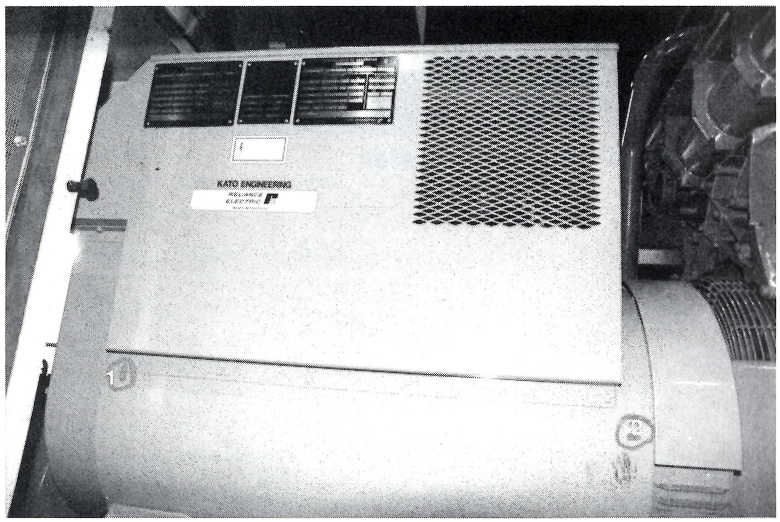


Figure 1-2: Auxiliary Alternators 1 & 2

- Each traction motor is directly geared to an axle and pair of driving wheels.

- The trucks, which contain the motor and wheel arrangements, support all the locomotive weight, yet provide for flexibility to turn the locomotive, absorb any shocks and still provide maximum traction for the wheels.

- The Programmable Electronic Engine Control panel (PEEC) is a modular plug-in electronic panel located in the electrical compartment. It allows the locomotive to use maximum diesel engine horsepower over wide variations in locomotive speed and load.

  Except for manual operation of cab controls, locomotive operation is controlled automatically by the PEEC. Various alarms and safety devices will alert the operator if any problems arise.

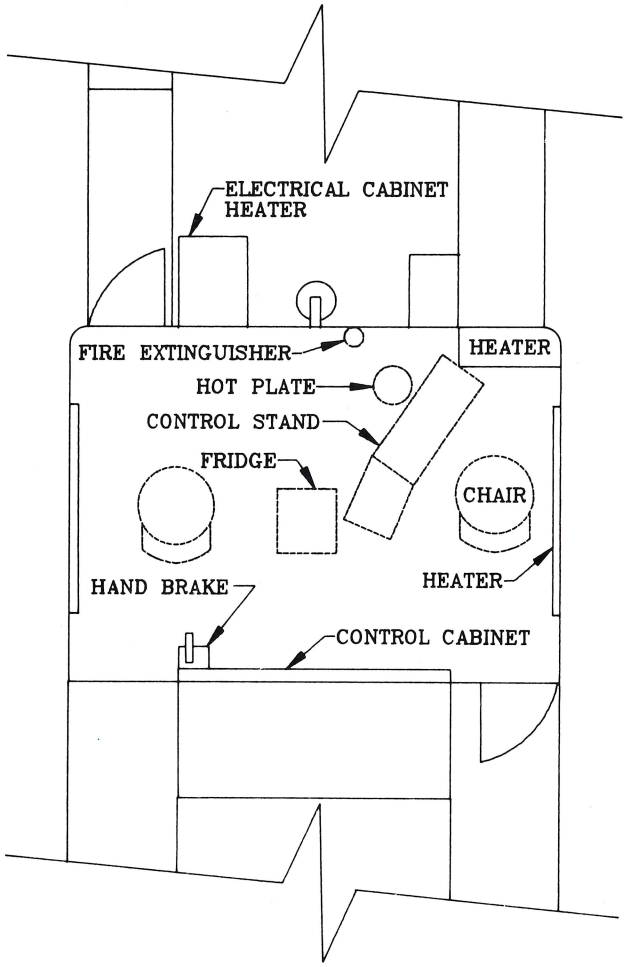
Chapter 2
Cab Controls and Indicating Devices

2.0 Introduction

This chapter briefly describes the controls and indicating devices the operator can use. Although some of the equipment is not used during normal operation, operators should understand how each piece functions.

Most controls and indicating devices are located in the locomotive cab. The engine room holds additional engine starting, stopping and monitoring equipment.

Operating equipment is located in two places in the locomotive cab: the Operator's Control stand and the Control Cabinet.



CAB LAYOUT

Figure 2-1: Locomotive Cab

2.1 Operator's Control Stand

The operator's control stand contains switches, gauges and operating handles. This section describes the location, function and operating features of each.

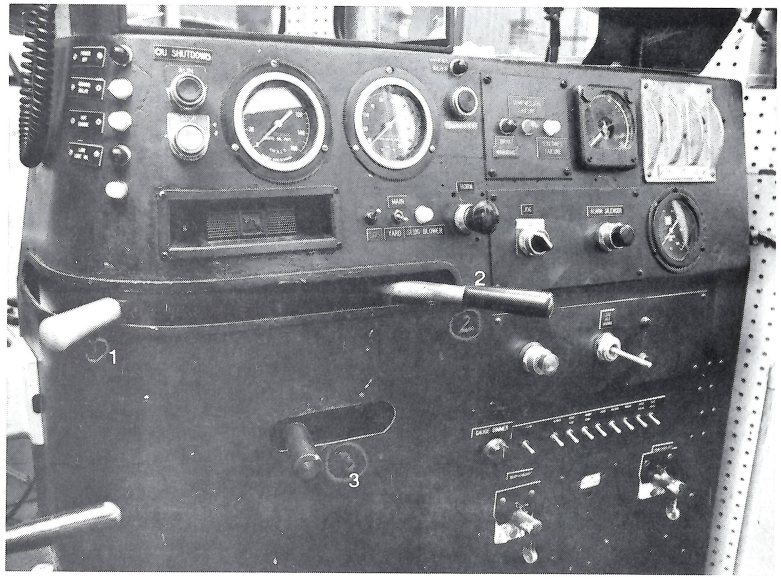


Figure 2-2: Operator's Control Stand - Handles

1. *Dynamic Brake and Transition Selector Handle*
2. *Throttle Handle*
3. *Reverser Handle*

Handles

1. Dynamic Brake and Transition Selector Handle

Location: to the left of the throttle handle

Function:

- to control dyanmic braking
- to set up locomotives without automatic transition to run as trailing locomotives

Operating features:

Dyanmic Brake Control
Move the handle from left to right to increase the braking effort. There are two detent positions, OFF/SET-UP. The handle may move freely without any notching in positions 1 through 8.

Mechanical interlocks prevent the handle from moving, unless the throttle is in IDLE and the reverser is positioned in either forward or reverse.

Caution: During the transfer from power to dynamic braking, hold the throttle in IDLE for 10 seconds before moving the dynamic brake handle to SET-UP position. This eliminates a sudden surge of braking effort, which could cause possible train run-in or motor flash over.

Manual Transition Trainline Control
Move the handle from right to left to four detent positions numbered 1-4. Each position sends trainline signals that set the traction motor configurations.

Note: This applies to trailing locomotives that require manual transition only. The CRS20 unit does not use transition. It is connected in parallel in normal operation, and in series/parallel in slug operation.

Traction Motor Configurations		
Position #	Motor Connections	Speed (mph)
1	Series-Parallel	0-18
2	Series-Parallel Fields Shunted	18-27
3	Parallel	27-48
4	Parallel Fields Shunted	48-65

You can select different positions throughout the speed range to achieve maximum horsepower. Mechanical interlocking prevents movement unless:

- the throttle is in IDLE and
- the reverser is in either forward or reverse.

2. Throttle Handle

Location: to the right of the dynamic brake and manual transistion Handle

Function: increases and decreases the locomotive power

Operating features: This handle can be moved from right to left in nine positions: IDLE and 1 through 8. Mechanical interlocking prevents the handle from moving:

- if dynamic brake control is in SET-UP or beyond, or
- if the reverser is centered and the handle removed.

3. Reverser Handle

Location: the lowest handle on the Control Stand

Caution: Do not move the reverser from forward to reverse or from reverse to forward while the locomotive is in motion. Damage to the traction motors may occur. Change the reverser direction only when the locomotive is completely stopped.

Function: controls the direction of the locomotive

Operating features:

There are three positions: right, left and centered.

- Move the handle to the right, towards the short hood end of the unit, to set up circuits to move the locomotive in a forward direction.
- Move the handle to the left, towards the long hood end, to set up circuits to move the locomotive in a reverse direction.
- When the handle is centered, mechanical interlocking prevents the Dynamic Brake and Transition Selector handle from moving, but the throttle handle can be moved. Power is not applied to traction motors from the center position.

  Removing the reverser handle in the centered position locks the throttle, dynamic brake and transition handles.

Pushbuttons

The following table describes the pushbuttons on the Operator's Control Stand.

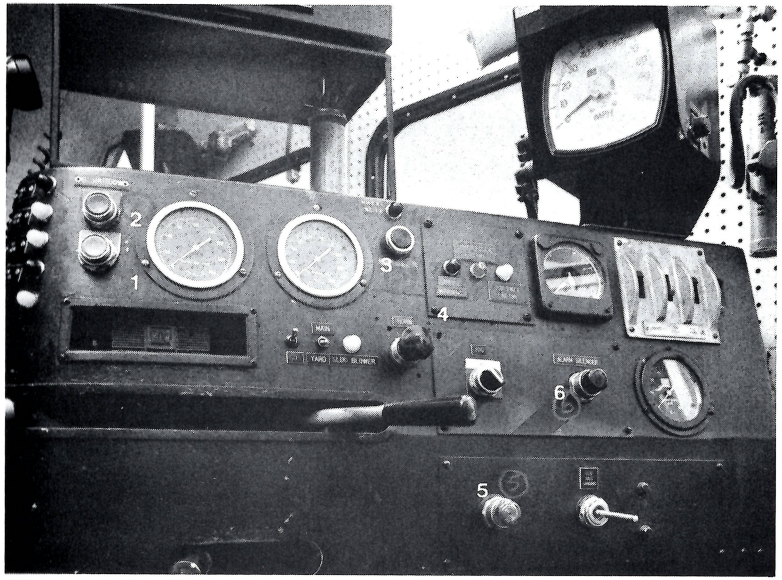


Figure 2-3: Operator's Control Stand - Pushbuttons

1. *MU Shutdown Trip Button*
2. *MU Reset Button*
3. *Sanding Pushbutton*
4. *Horn Pushbutton*
5. *RSD Pushbutton*
6. *Alarm Silencer Pushbutton*

Button	Push to...
1. MU Shutdown Trip Button (red)	simultaneously shut down the engines of a multiple unit consist. On a Caterpillar diesel engine, two air shut-off values close, preventing air from leaving the turborcharges and reaching the diesel engine. **Note: For "Emergency" use only.**
2. MU Reset Button (black)	to reset the red MU Shutdown Trip button. (Reset air dump valves)
3. Sanding Pushbutton	energize trainline control of sanders in a multiple unit consist and to control front and rear locomotive sanding below 7 mph, depending on direction of travel
4. Horn Pushbutton	sound the locomotive air horn.
5. RSD Pushbutton	manually reset the locomotive Reset Safety Device (See Chapter 4 for more information about the Reset Safety Device.)
6. Alarm Silencer Pushbutton	silence the alarm in the locomotive cab. The alarm can sound from the controlling locomotive or trailing unit.

Breakers and Switches

The following table describes the breakers, switches and controls on the Operator's Control Stand.

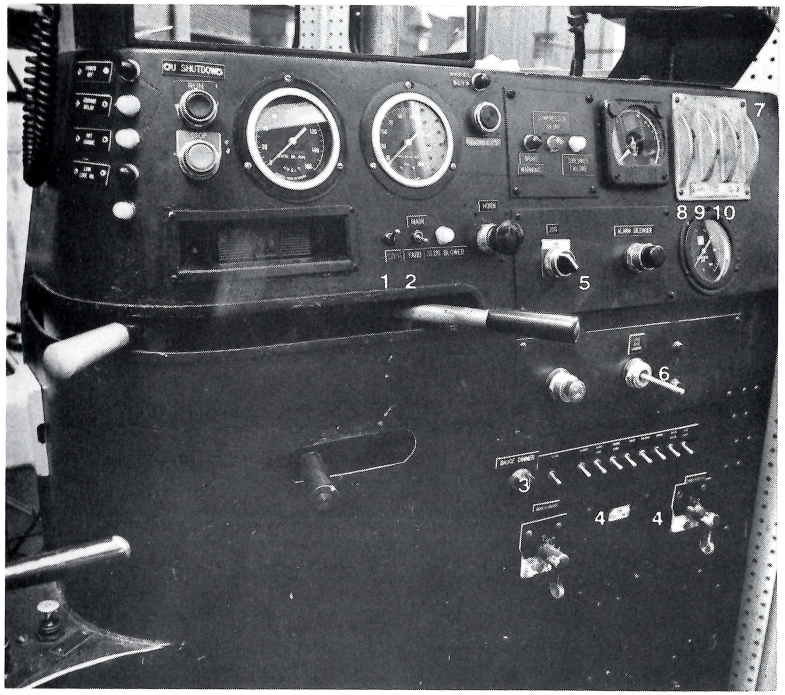


Figure 2-4: Operator's Control Stand - Breakers & Switches

1. *SOS (Slug Operate Switch)*
2. *Main/Yard Switch*
3. *Gauge Dimmer*
4. *Front & Rear Headlight Switches*
5. *Jog Switch*
6. *Lead Axle Sanding Switch*
7. *BKCB (Dyanamic Brake Control Breaker)*
8. *Control Switch*
9. *Generator Field Switch*
10. *Fuel Pumps Switch*

***Note:** Units 601-604 are equipped with ditch lights*

Breaker/Switch	Function
1. SOS (Slug Operate Switch)	Allows locomotive operation with or without a slug. **Note: SOS must be in the OFF position when no slug unit is attached, otherwise the Master Unit will indicate VAPR failure.**
2. Main/Yard Switch	Controls the rate of engine response, measured in rpm per second. • Use the Up position while operating on mainline for slower, smoother power application. • Use the Down position during yard switching for quicker locomotive power response.
3. Gauge Dimmer	Turn the knob to control the intensity of the gauge lights on the control stand.
4. Front and Rear Headlight Switches	Control the locomotive's front and rear headlights. Used in conjuction with the MU headlight set-up switch.
5. Jog Switch	Moves the locomotive with battery power when the engine is shut down. **Note: Used by shop forces for maintenance purposes only.**
6. Lead Axle Sanding Switch	Allows operator control of lead axle sanding at speeds under 7 mph. Above 7 mph, sander operation is automatically controlled.

Breaker/Switch	Function
7. BKCB Breaker (Dynamic Brake Control Breaker)	Protects the braking control rheostat and control wires from excessive current during the braking operation. If the breaker in is the TRIP or OFF position, it restricts lead and trailing units from loading in dynamic braking.

The following three switches are located in the upper right corner of the control stand. Move the switches upward to switch them ON. The switches must all be ON when the locomotive is operating as a lead unit. Turn OFF when locomotive operates as a trailing unit.

8. Control Switch (left)	Turn ON to control the engine speed. When OFF, the engine runs at idle speed regardless of throttle handle position.
9. Generator Field Switch (center)	Turn ON to complete the excitation circuits to the main generator. When OFF, the locomotive responds to throttle, but the generator does not provide power.

Breaker/Switch	Function
10. Fuel Pumps Switch (right)	Turn ON to control the fuel pump operation on locomotives wired for electrical fuel pump control. When OFF, the engine shuts down due to loss of pump control in trailing locomotives. **Note:** CRS20 locomotives use a mechanically driven fuel pump.

Gauges

The following table describes the gauges on the Operator's Control Stand.

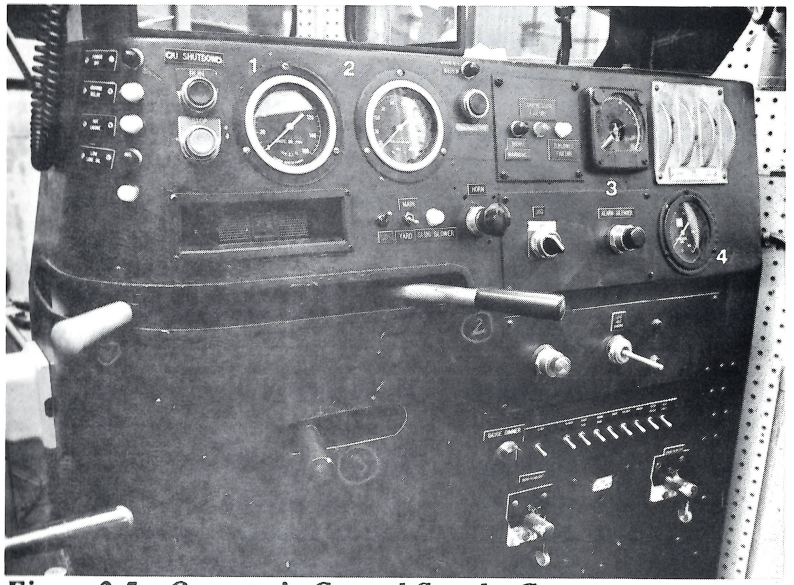


Figure 2-5: Operator's Control Stand - Gauges

1. *Brake Cylinder/Brakepipe Gauge*
2. *Equalizing/Main Reservoir Gauge*
3. *Load Meter*
4. *Control Air Gauge*

Gauge	Function
1. Brake Cylinder/ Brakepipe Gauge	The white pointer indicates brakepipe pressure. The red pointer indicates locomotive brake cylinder pressure.
2. Equalizing/Main Reservoir Gauge	The white pointer indicates equalizing reservoir pressure. The red pointer indicates pressure in the locomotive main reservoirs.
3. Load Meter	Registers the locomotive pulling force. The meter shows the average traction motor current in amperes of electrical current. The maximum is 1800 amperes. A yellow area on the meter indicates when current levels are too high for continuous operation.

Caution: If the needle is in the yellow area, do not exceed the rating times for maximum continuous current. The maximum continuous current is applied only at the 8th notch engine speed. These values decrease as engine speed and cooling air decrease.

Gauge	Function
Control Air Gauge	Shows the operating air pressure supplied to the locomotive power contactors, reverser and dynamic brake switch.
Speedometer	Measures the locomotive speed from 0 to 100 mph. Use the dimmer control on the left side to increase or decrease its lighting.

Indicator Lights

The following table identifies each indicator light on the Operator's Control Stand. Refer to Chapter 5, Troubleshooting for detailed isolation procedure

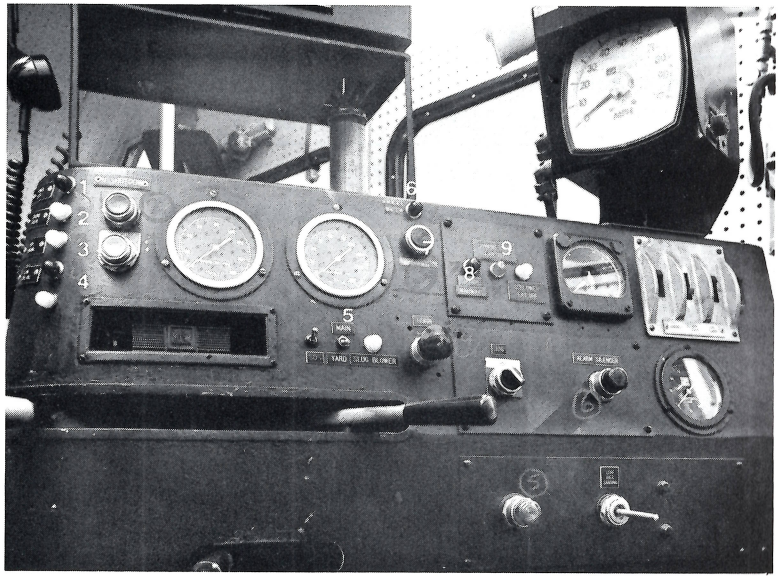


Figure 2-6: Operator's Control Stand - Indicator Lights

1. *Power Off Light*
2. *Ground Relay Light*
3. *Hot Engine Light*
4. *Low Lube Oil Light*
5. *Slug Blower Light*
6. *Wheel Slip Light*
7. *Brake Warning Light*
8. *Compressor Failure Light*
9. *DB Blower Failure Light*

Light	Color	Indicates..	Causes
1. Power Off	White	the power cut-off function is on. Engine will not load and engine speed is restricted to idle.	• Operating the automatic brake valve in emergency position. • Resetting safety device trip. • Trainline break-in-two.
2. Ground Relay	White	operation of the ground relay cut-out has prevented engine loading.	• High voltage power from the main generator is being conducted to ground. • Fuse/rectifier failure in the main alternator.
3. Hot Engine	Red	diesel engine is running at excessive temperatures.	

Light	Color	Indicates...	Causes
4. Low Lube Oil	Green	diesel engine lubricating oil pressure is too low or the oil level is insufficient. If the green light is on during an engine shutdown, oil pressure is too low.	
5. Slug Blower	Amber	one or both cooling blowers on the traction motor have failed on the slug. This light can also indicate an electrical problem in the propulsion control circuit.	
6. Wheel Slip	White	wheels are slipping during locomotive operation.	
7. Brake Warning	Amber	braking grid currents are excessive during dynamic brake operation.	

Light	Color	Indicates...	Causes
8. Compressor Failure	White	compressor control breaker tripped.	• Compressor control contactors failed to synchronize during start-up or shutdown. • Compressor oil pressure is too low.
9. DB Blower Failure	Blue	resistor cooling motor on dynamic brake failed.	

Air Brake Equipment

Locomotives use type 26L Air Brake equipment. The equipment is located to the left of the dynamic brake and throttle handles. Equipment includes:

- an automatic brake valve
- a cut-off valve
- a regulating valve
- an independent brake valve
- a multiple unit valve (MU2A).

The 26L air brake equipment also allows the locomotive to operate as a dead engine. The dead engine cut out cock is found through side doors under the locomotive cab.

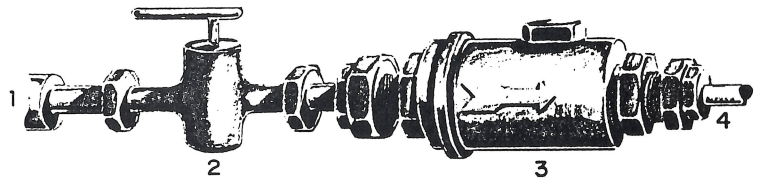


Figure 2-7: Dead Engine Cut Out Cock

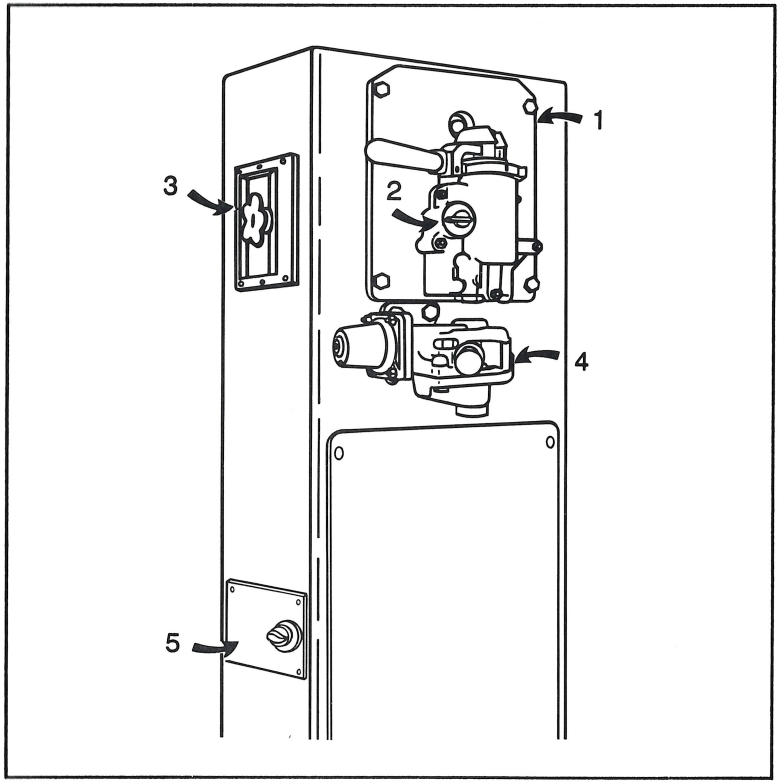


Figure 2-8: Air Brake Equipment

1. *Automatic Brake Valve*
2. *Cut-Off Pilot Valve*
3. *Regulating Valve*
4. *Independent Brake Valve*
5. *Multiple Unit Valve*

1. Automatic Brake Valve

Function: controls the braking action -- both application and release -- on the locomotive and the train

Operating features: This "pressure maintaining" brake valve holds brake pipe reductions constant against brakepipe leakage. The following table describes each position.

Position	Handle Location	Use
1. Release	At the extreme left of the quadrant	To charge the air brake equipment and release the locomotive and train brakes.
2. Minimum Reduction	Against the first raised portion on the quadrant to the right of release position	To obtain minimum braking effort. Brakepipe pressure reduces between 5-7 psi.
3. Service Zone	Moving in a sector to the right of release position	To control the braking effort. Move the handle from left to right through the service zone to increase the braking effort.
4. Full Service	Extreme right of the service zone	To apply full braking effort.
5. Suppression	Against the second raised portion of the quadrant to the right of release position	To recover the penalty brake application caused by the safety device or overspeed control.

Position	Handle Location	Use
6. Handle Off	By the third quadrant notch to the right of release position	Use on trailing units of a multiple unit consist, or on locomotives being towed "dead" in a train. The handle can be removed in this position.
7. Emergency	To the extreme right of the brake valve quadrant	To make or recover emergency brake applications.

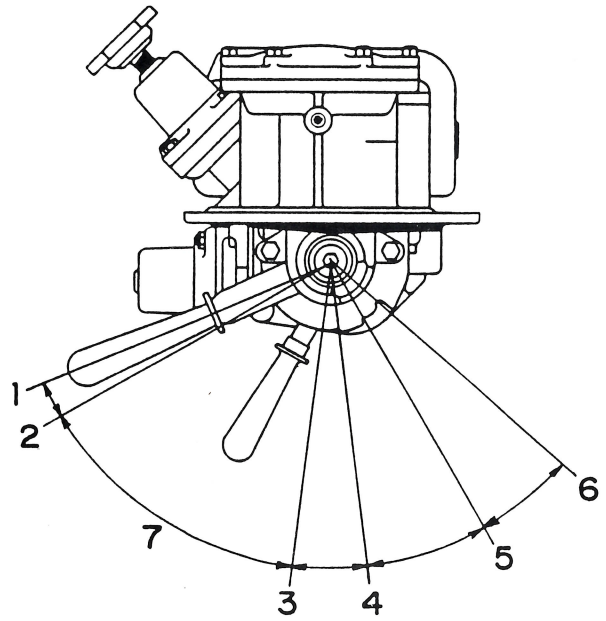


Figure 2-9: Automatic Brake Valve Positions

1. *Release*
2. *Minimum Reduction*
3. *Full Service*
4. *Suppression*
5. *Handle Off*
6. *Emergency*
7. *Service Zone*

2. Cut-Off Pilot Valve

Location: on the automatic brake valve housing, below the brake handle

Function: determines the type of operation of the locomotive

Operating features: Push in and rotate the valve to any of the following positions.

Position	Use
FRT (freight)	To operate the locomotive as a controlling unit
OUT	To haul the locomotive "dead" or as a trailing unit in a consist
PASS (passenger)	To operate as a lead unit for passenger equipment or as instructed

3. Regulating Valve

Location: behind the automatic brake valve, on the left side

Function: to regulate a selected brake pipe pressure

Operating features:

- The automatic brake valve must be in release position.
- Select the appropriate brake pipe pressure with the regulating valve.
- The automatic brake valve maintains the selected pressure to prevent overcharge or leakage.

4. Independent Brake Valve

Location: directly below the automatic brake valve

Function: provides independent control of the locomotive braking effort, regardless of train braking effort

Operating features: The brake valve is self-lapping and holds the brakes applied. The two positions, Release and Full Application, and the Service Zone are described in the following table.

Position	Handle Location	Use
1. Release	At the extreme left of the quadrant	When the automatic brake valve is in the release position, depress to release any automatic braking on the locomotive.
2. Service Zone	Between the release and full application positions	Move the handle from left to right to increase the locomotive braking effort. When the valve is in the service zone, depress to release the automatic application of the locomotive brakes to the valve corresponding to the position of the independent brake valve handle.
3. Full Applica-tion	At the extreme right of the quadrant	To apply maximum locomotive braking effort.

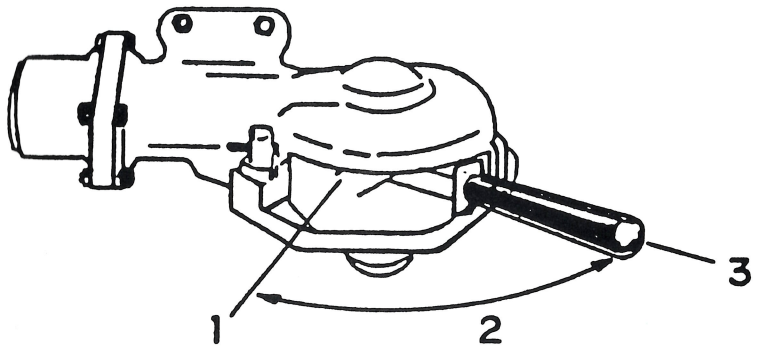


Figure 2-10: Independent Brake Valve Positions
1. Release
2. Service Zone
3. Full Application

5. Multiple Unit Valve (MU2A)

Location: lower left-hand side of the air brake stand

Function: sets the independent brake valve for lead or trail operation

Operating features: Push in and turn the valve to one of the following positions.

Position	Use When Locomotive Is...
LEAD or DEAD	leading or hauled dead in a train.
TRAIL 26	trailing 26 brake equipped units.

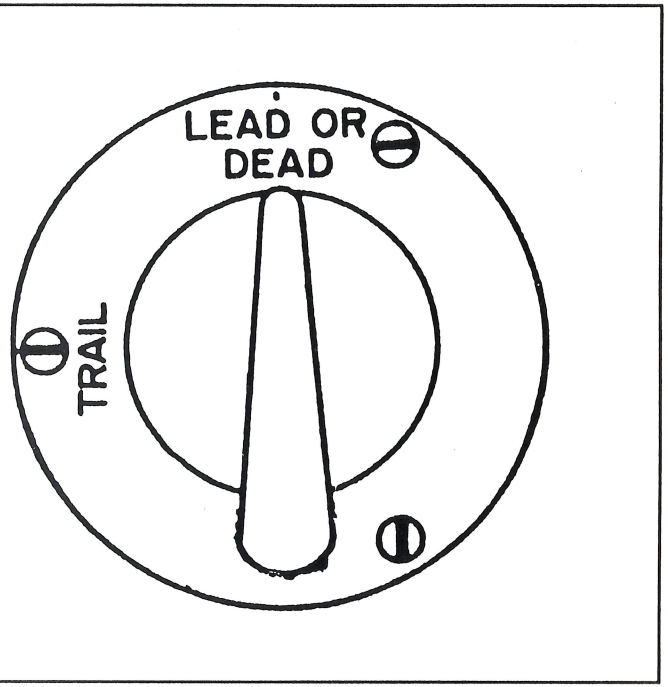


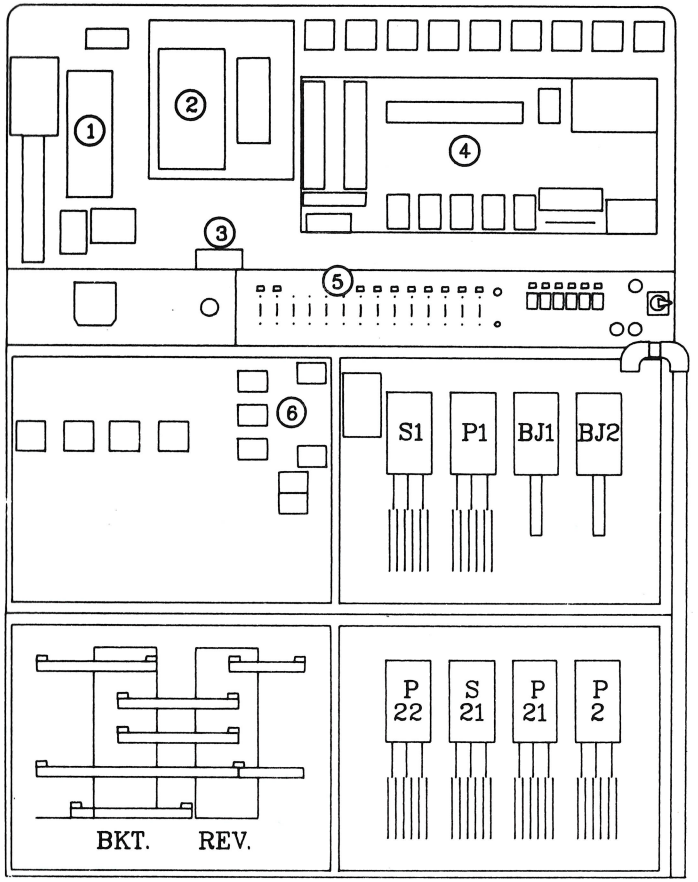
Figure 2-11: Multiple Unit Valve Positions

2.2 Control Cabinet

The engine control cabinet contains switches and controls. This section describes the location, function and operating features of each.

Figure 2-12: Control Cabinet - Panels

1. *Auto Start Panel*
2. *Programmable Electronic Engine Control Panel (PEEC)*
3. *Excitation Delay Relay*
4. *Engine Control Panel*
5. *Breaker Panel*
6. *Wheel Slip Panel*



1. AUTO START PANEL
2. PEEC PANEL
3. EXCITATION DELAY
4. ENGINE CONTROL PANEL
5. BREAKER PANEL
6. WHEEL SLIP PANEL

CONTROL CABINET

Panels

1. Auto Start Panel

Function: keeps the engine warm and ready for immediate use when the locomotive is not in service

Operating features: The Auto Start Panel automatically starts the engine, self-loads it until the engine is hot, then automatically shuts down the engine when it is properly conditioned.

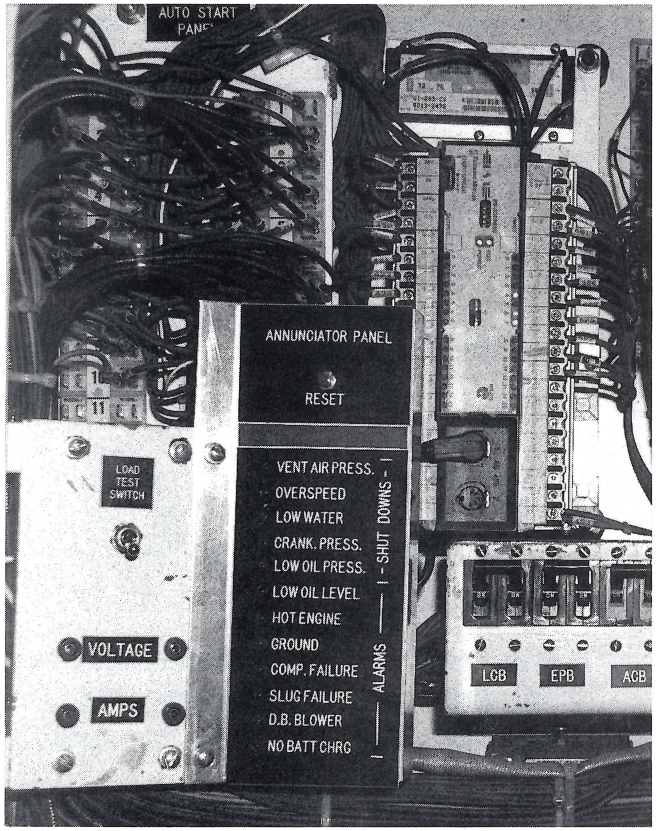


Figure 2-13: Auto Start Panel

2. Programmable Electronic Engine Control Panel (PEEC)

Location: in the cast aluminum box in the control cabinet

Functions:

- controls engine speed
- regulates engine load at selected power level for each throttle position
- limits generator voltage to predetermined levels for each throttle position
- limits generated current to set power matching schedules for each throttle position
- detects and regulates wheel slippage and triggers automatic sanders
- limits traction motor current to set power matching schedules for each throttle position
- regulates motor field current in dynamic braking
- regulates grid current in dynamic braking

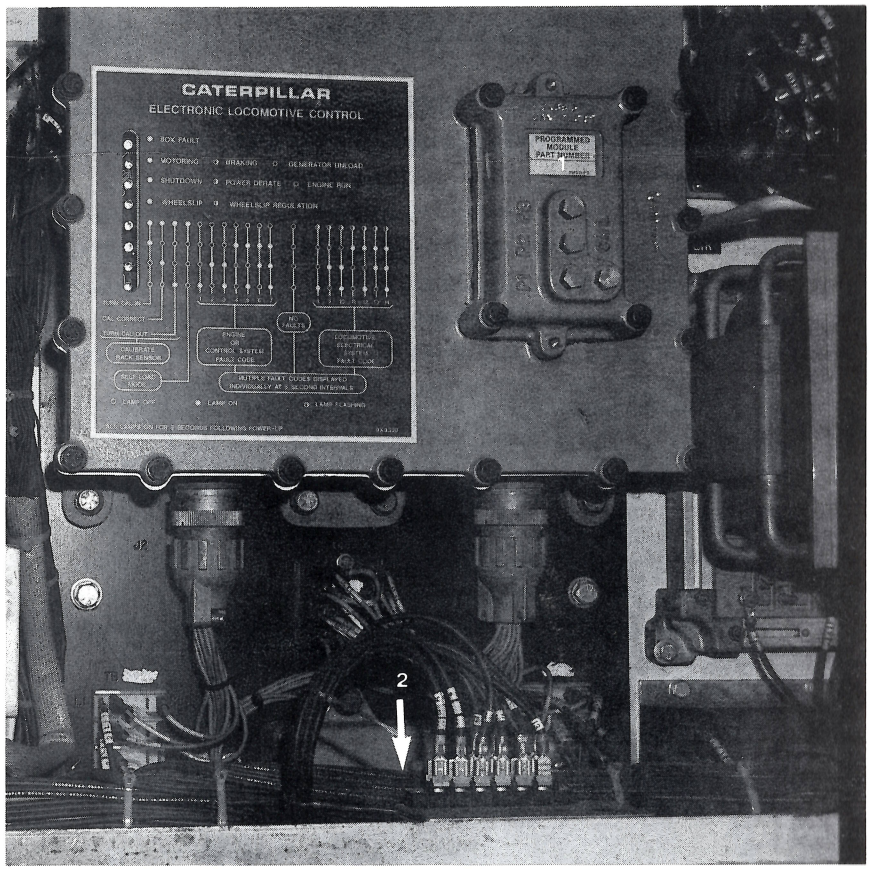


Figure 2-14: Programmable Electronic Engine Control Panel (PEEC)

1. *Personality Module*
2. *Derate Module*

1. Personality Module

Location: small box in the centre of the PEEC box

Function: determines the characteristics of a particular control unit. The Personality Module is pre-programmed. It is not field programmable.

2. Derate Module

Function: sends five derate channel analog signals to the PEEC Panel, in addition to the voltage and current sense inputs.

Operating features: The Derate Signals are as follows.

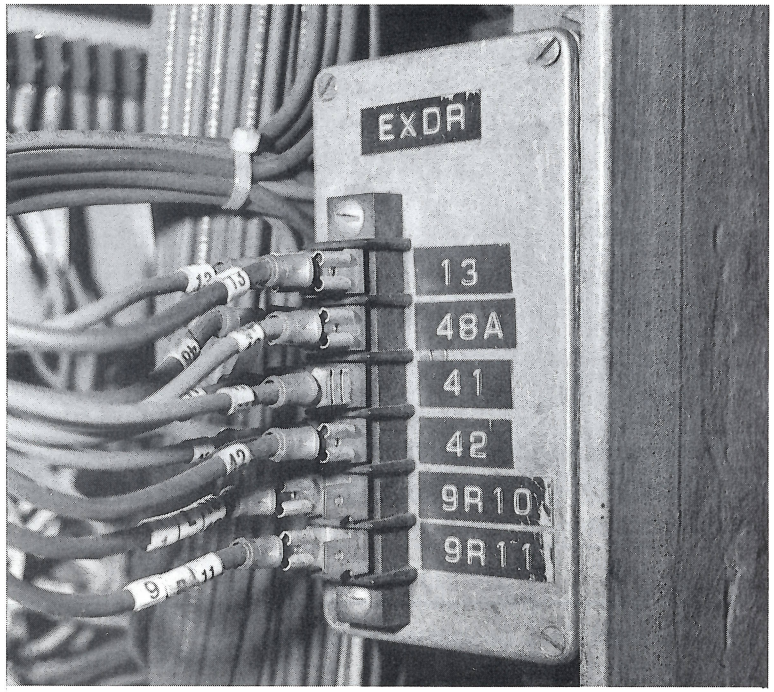
Signal	Source
High traction motor current	Wheel Slip Panel
Low traction motor current	Wheel Slip Panel
24T Trainline signal	Dynamic Braking
Altitude signal	Built into the Derate Module
Engine Coolant Temperature	Coolant temperature sensors

If the PEEC Panel identifies an incorrect signal, it acts to limit the excitation.

3. Excitation Delay Relay (EXDR)

Location: top mid-section of the Control Cabinet

Function: delays the opening of the power contactors until the alternator power level is low enough not to cause any damage



4. Engine Control Panel

The Electronic Speed Switch, the Overspeed Reset Switch and various other relays are located on the Engine Control Panel.

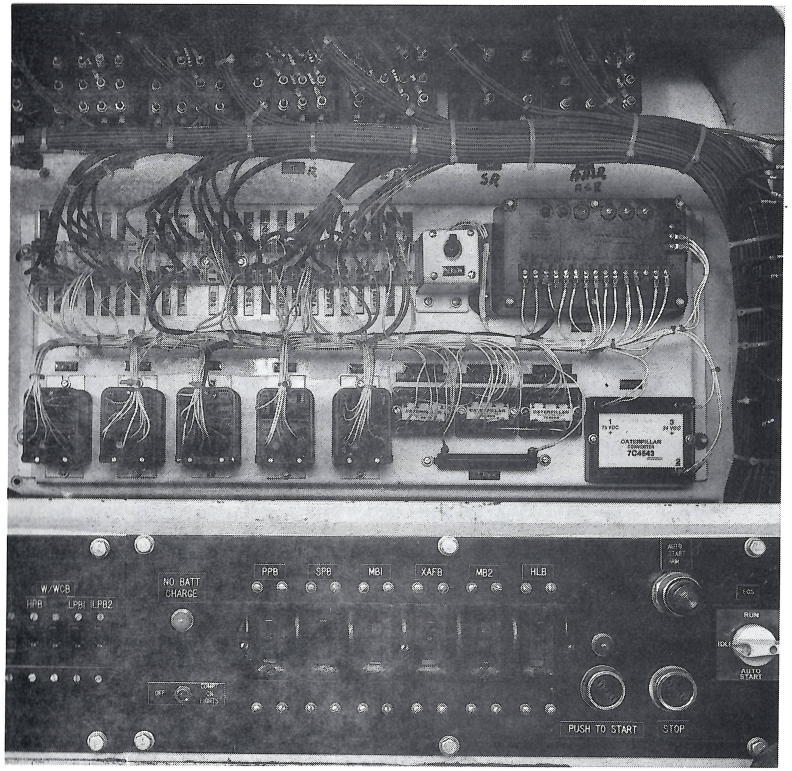


Figure 2-16: Engine Control Panel

Ground Relay Reset

Location: behind the centre electrical compartment door on the operator's side of the Control Panel

Function: resets the ground relay device

Operating features: During power operation, high voltage electrical grounds cause the ground relay device to operate. If three or more trips occur, the ground relay device locks in, cutting off power to the locomotive. Press the black pushbutton to reset the device and allow the locomotive to operate.

The ground relay also detects problems within the main alternator.

Danger: Improper use can cause personal injury or severe equipment damage. Consult the supervisor of train and engine service or shop personnel before resetting the device.

Electronic Speed Switch (ESS)

Location: mounted on the right, top corner in the Electrical Cabinet on the Engine Control Panel

Function: detects crank speed, terminate speed, high oil pressure shutdown speed and engine overspeed and provides a 9 second time delay used during start up

Operating features: The ESS speed switch receives a speed signal from a magnetic pick up that counts teeth on the fly-wheel ring gear. It uses this signal to determine the engine speed.

Breakers and Switches

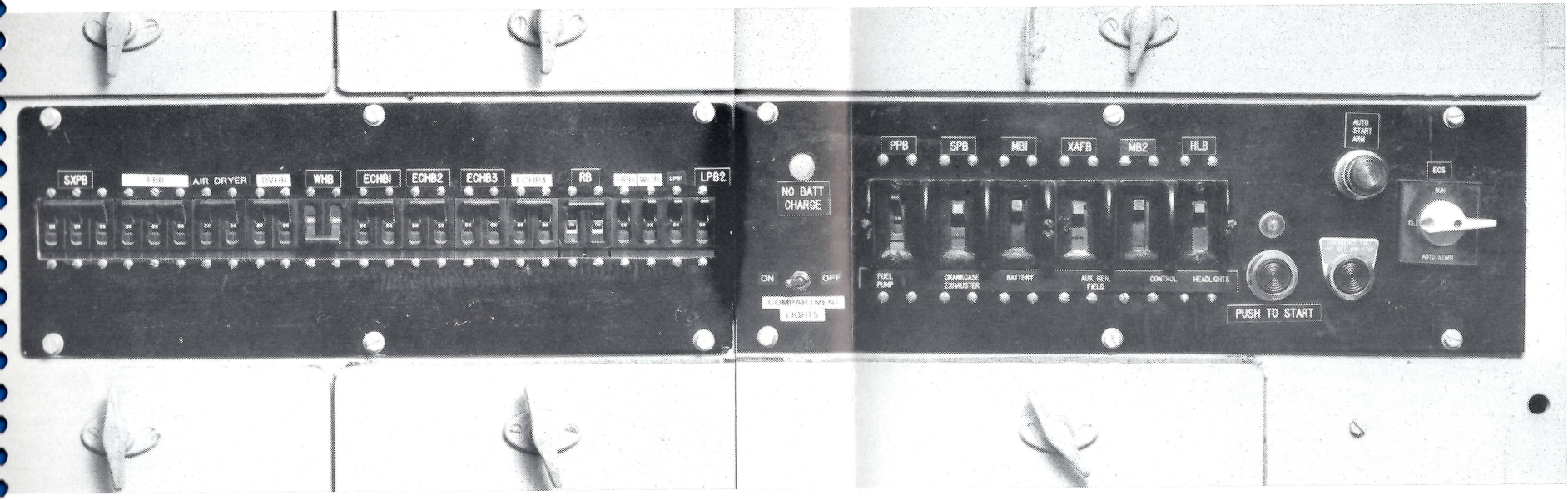
The following table describes the breakers, switches and indicators located in the black area of the Engine Control Panel.

Abbreviation	Name	Function
SXPB	Slug Auxiliary Power Breaker	The 70A breaker supplies variable three-phase AC voltage to traction motor cooling blowers on the slug unit.
FBB	Filter Blower Breaker	Supplies variable three-phase AC power to the Inertial Filter Blower Motor.
WHB	Window Heater Breaker	Supplies power to electrically heated windows mounted in the locomotive cab.

Abbreviation	Name	Function
ECHB1	Electric Cab Heater Breaker	Supplies power to baseboard heater on the right side of the locomotive.
ECHB2	Electric Cab Heater Breaker	Supplies power to baseboard heater on the left side of the locomotive.
ECHB3	Electric Cab Heater Breaker	Supplies power to the engineman's electric wall heater.
ECHB4	Electric Cab Heater Breaker	Supplies power to the trainman's side wall heater.
RB	Radio Breaker	Supplies power to the communication radio above the control stand.
HPB	Hot Plate Breaker	
W/WCB	Whistle and Water Cooler Breaker	
LPB1	Cab Lighting Breaker	Supplies power to all gauge lights, load meter, flow meter, front classification lights, slug auxillary lights and walkway lights.

Abbreviation	Name	Function
LPB2	Cab Lighting Breaker	Supplies lighting power to the ground, number, engine room, control compartment, engineman's reading, trainman's reading, dome and short hood lights.
NO BATT CHARGE (white light)		Indicates a failure of the battery charging circuit.
COMP LIGHTS Switch		Controls the electrical compartment lights.
PPB	Pre-Lube Pump Breaker	Must be on during the start operation to allow the pre-lubrication pump for the diesel engine to operate.
SPB	Snow Plow Breaker	Controls the snow plow receptacle on the front of the locomotive.
MB1	Master Battery Breaker	The 200 amp breaker protects the auxillary generator from excessive current draw. (Wired in the positive supply circuits.)
MB2	Master Battery Breaker	Same as MB1, but wired in the negative circuits.
HLB	Headlight Breaker	Supplies power to front and rear headlight circuits.

Abbreviation	Name	Function
XAFB	Auxiliary Alternator Field Breaker	Protects the auxillary generator field circuits.


SXPB
AIR DRYER
WHB
ECHB1
ECHB2
ECHB3
RB
LPB2
NO BATT CHARGE
ON
OFF
COMPARTMENT LIGHTS
PPB
SPB
MB1
XAFB
MB2
HLB
FUEL PUMP
CRANKCASE EXHAUSTER
BATTERY
AUX. GEN. FIELD
CONTROL
HEADLIGHTS
PUSH TO START
AUTO START
ECS
RUN
AUTO START

5. Breaker Panel

The Traction Motor Cut-Out Switch and the MU Headlight Set-Up Switch are located on the breaker panel on the front of the control cabinet.

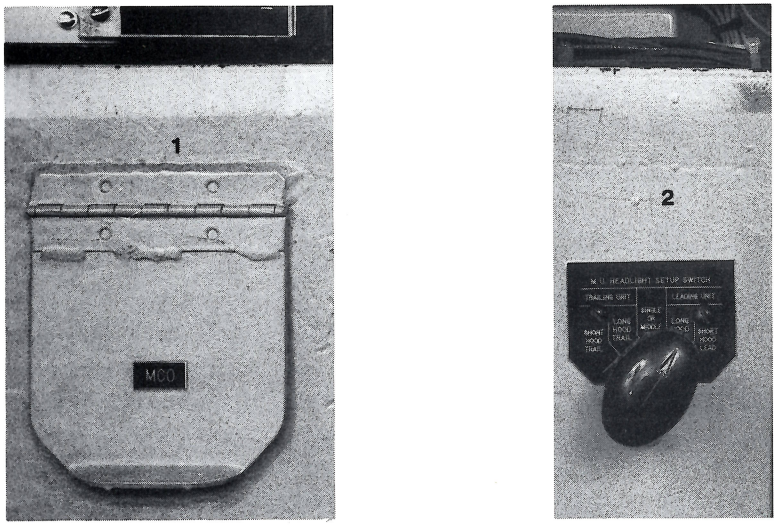


Figure 2-17: Breaker Panel

1. *Traction Motor Cut-Out Switch*
2. *MU Headlight Set-Up Switch*

1. Traction Motor Cut-Out Switch

Location: left side of the Breaker Panel on the front of the Control Cabinet

Function: isolates traction motors in the event of high voltage grounds or other defects

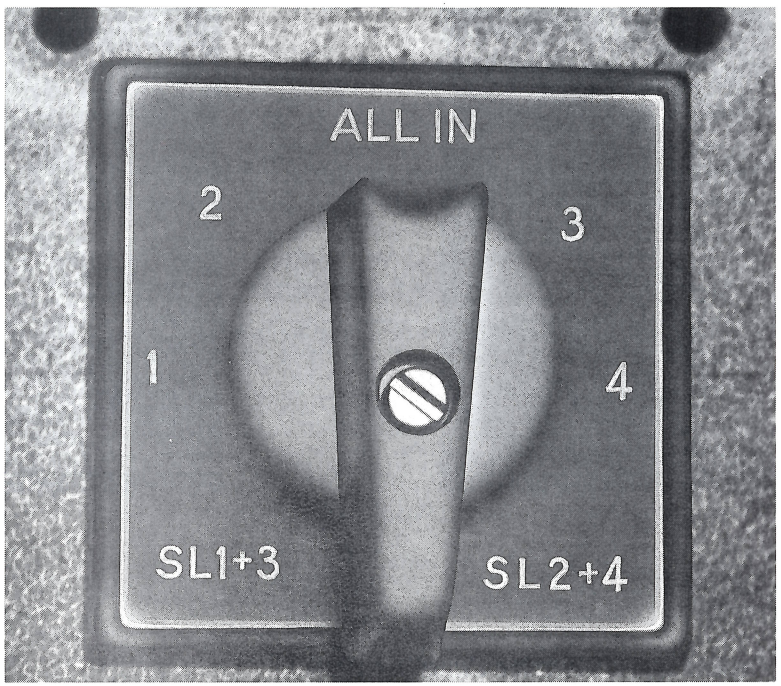


Figure 2-18: Traction Motor Cut-Out Switch

Operating features: The seven (7) position switch functions differently when the master unit is working with the slug unit at speeds below 17 mph. Below 17 mph, all motors are connected in a series-parallel configuration. The motor cut-out switch isolates the defective motor and the motor it is paired with.

When working as a single unit, the switch can be used to isolate an individual motor.

Danger: Do not cut-out motors while the unit is in power or dynamic brake operation. Personal injury or equipment damage may result.

2. MU Headlight Set-Up Switch

Location: on front of the control cabinet, to the right of the motor cut-out switch

Function: configures headlight circuits for different operating conditions

6. Wheel Slip Panel

Location: lower midsection of the control cabinet

Function:

- detects differential and synchronous wheel slip of the locomotive and the slug unit
- protects the DB grids

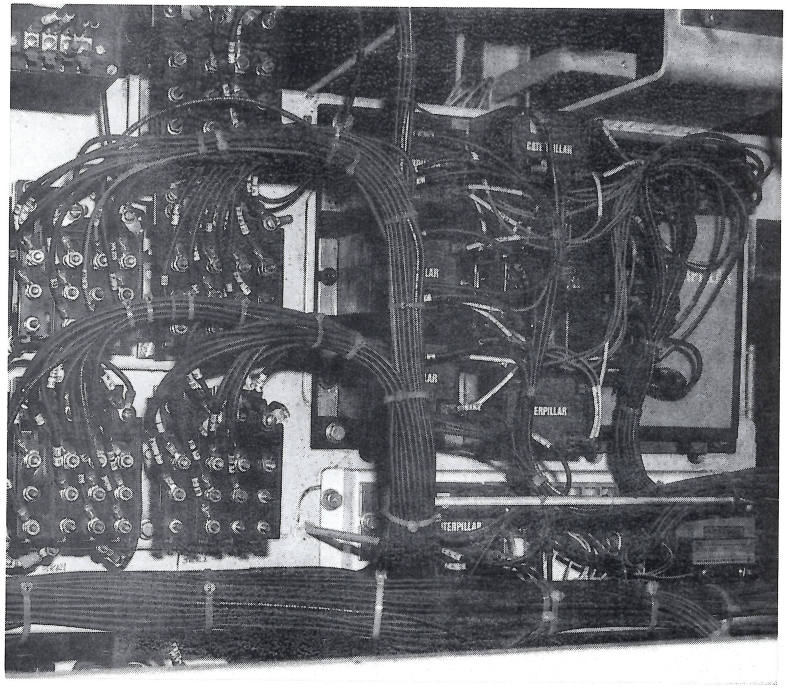


Figure 2-19: Wheel Slip Panel

Switches, Buttons and Lights

The control cabinet contains the following switches, pushbuttons and lights.

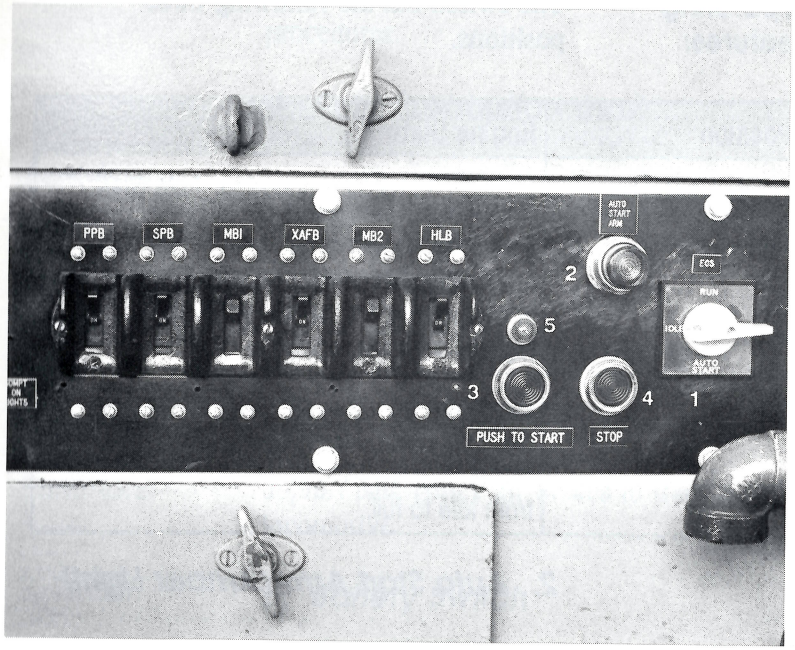


Figure 2-20: Control Cabinet - Switches, Buttons and Lights

1. *Engine Control Switch (ECS)*
2. *Auto Start Arm Light*
3. *Start Pushbutton*
4. *Stop Pushbutton*
5. *Pre-lube Pump/Start Light*

1. Engine Control Switch (ECS)

Function: controls the operating state of the engine

Operating features: The switch has the following three positions.

Position	Engine State
AUTO START	Engine can be conditioned for Auto Start.
IDLE	Excitation circuits are turned off and the locomotive will not load. Diesel engine speed is held at idle. Start the engine manually from this position.
RUN	Excitation circuits, locomotive power and dynamic brake operation are turned on. The diesel engine speed can now be increased from idle to full.

2. Auto Start Arm (Amber Light)

Location: to the left of the ECS switch

Function: flashes on and off to indicate that the Auto Start feature is on. Refer to Chapter 4 for detailed Auto Start information.

3. Start Pushbutton (black)

Function: push to start the engine pre-lube oil pump and engage the starters for diesel engine cranking. Refer to Chapter 4 for start procedures.

4. Stop Pushbutton (red)

Function: push to shut down the diesel engine without affecting other locomotives or to shut down the pre-lube oil pump before engine starting

5. Emergency Brake Valve

Location: below the ECS switch

Function: applies emergency air brakes to train and locomotive

6. Battery Switch

Location: behind the lower electrical compartment door on the trainman's side of the locomotive

Function: connects the 64 volt locomotive batteries to the control circuits

Operating features: The battery switch is a two-position knife switch. Move the handle to the upper (closed) position to supply power from the locomotive batteries.

7. Pre-Lube Pump/Start Light

Location: on the control module near the ECS

Function: indicates that the pre-lube oil pump is running in preparation for engine starting

Chapter 3
Engine Room Controls and Indicating Devices

3.0 Introduction

This chapter briefly describes the Engine Room controls and indicating devices that the operator needs to be aware of.

3.1 Engine Room Start Station and Gauge Panel

The engine start station and gauge panel are located on the engineman's side of the locomotive, near the free-end of the diesel engine. The start station and gauge panel contain meters, gauges and indicators lights. This section describes the function and operating features of each.

Gauge Panel

The following table describes the gauges on the engine room gauge panel.

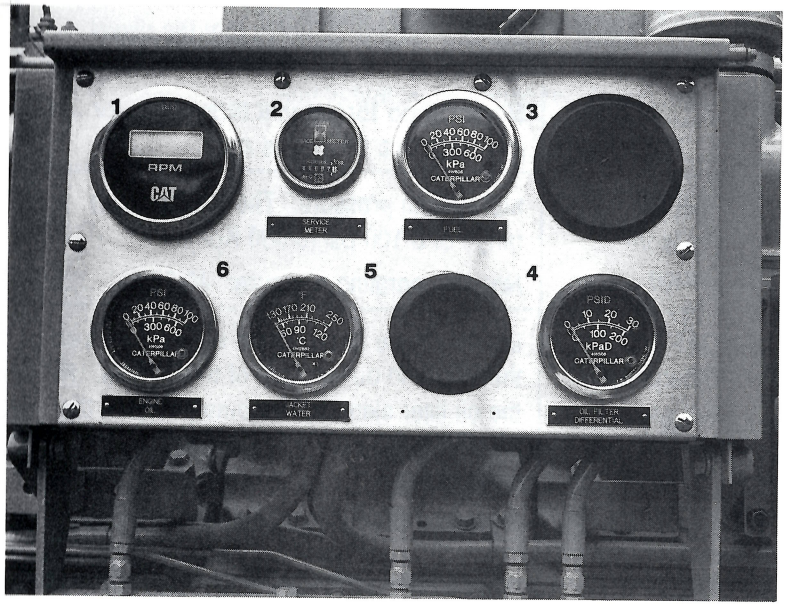


Figure 3-1: Gauge Panel

1. *Engine RPM Gauge*
2. *Service Meter*
3. *Fuel Oil Pressure Gauge*
4. *Oil Filter Differential Gauge*
5. *Engine Coolant Temperature Gauge*
6. *Engine Oil Pressure Gauge*

Gauge	Shows...
1. Engine RPM Gauge	the revolutions per minute of the diesel engine.
2. Service Meter	the total number of hours that the diesel engine has operated. **Note: Shop forces use this meter for maintenance purposes only.**
3. Fuel Oil Pressure Gauge	fuel system pressure. The gauge has a range of 0-100 psi (0-600 Kpa). Normal operating pressure: 40-65 psi
4. Oil Filter Differential Gauge	the difference between the oil pressures on the inlet and outlet sides of the oil filter. As the oil filter elements become plugged, the difference between the pressure on the two sides increases. Maximum pressure differential: 15 psi
5. Engine Coolant Temperature Gauge	engine water temperature in the jacket water circuit. Water temperature readings may vary according to load, but should never exceed the boiling temperature for the pressured system. Temperature range for engine water jacket water: 160°-210° F.

Gauge	Shows...
6. Engine Oil Pressure Gauge	engine oil pressure. Pressure readings are greatest after starting a cold engine. Oil pressure decreases as the engine warms up. Minimum engine oil pressure at rated speed and operating temperature: 40 psi

Start Station

The following lights and pushbuttons are located on the engine room start station.

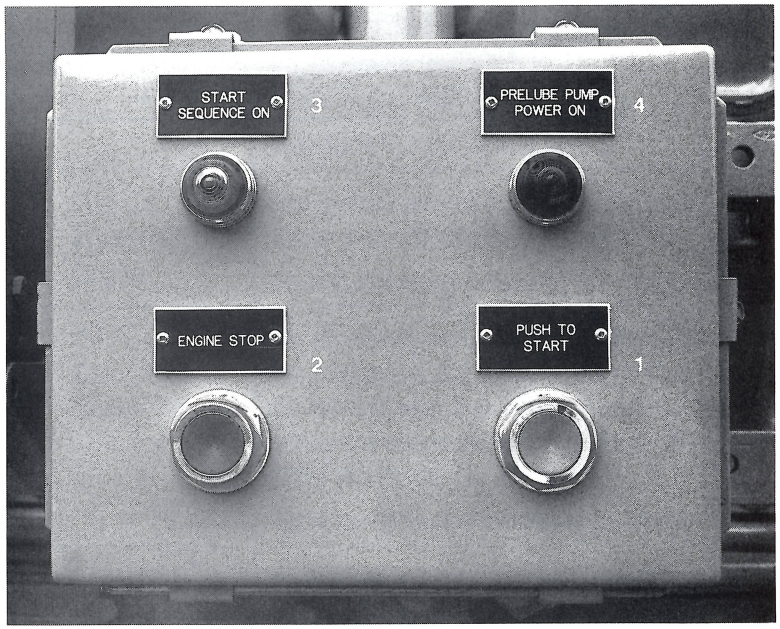


Figure 3-2: Start Station

1. *Start Pushbutton*
2. *Stop Pushbutton*
3. *Start Sequence On Light*
4. *Pre-lube Pump Power On Light*

1. Start Pushbutton (Green)

Function: push to arm the diesel engine pre-lube pump and engage starters to start up the diesel engine

2. Stop Pushbutton (red)

Function: push to shut down the diesel engine without affecting other locomotives in the consist

3. Start Sequence On Light (green)

Function: shows that engine lube oil system is pressurized when lit

4. Pre-lube Pump Power On Light (amber)

Function: shows that engine pre-lube oil pump is running when lit

3.2 Engine Starting Contactors and Starter Motors

This section describes the functions and operating features of the engine starting relays and starter motors.

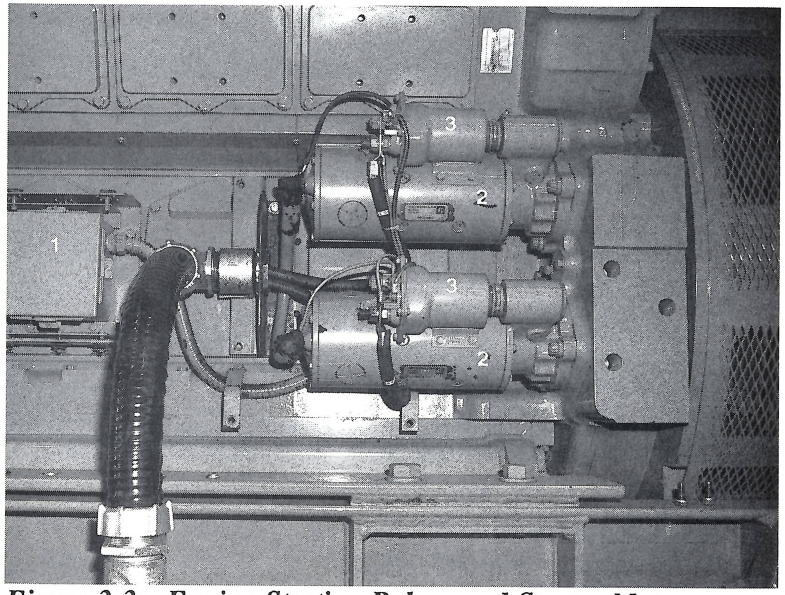


Figure 3-3: Engine Starting Relays and Starter Motors

1. Starting Relays
2. Starter Motors
3. Starter Motor Solenoids

1. Starting Contactors

Function: energize the starting motors

Operating features: Auxiliary Starting Contactor (STA) energizes to pick-up starter motor solenoids. Both starter motor solenoids must pick-up to complete a series circuit to energize Starting Contactor (ST), which in turn connects high battery current to the starter motors. The 'STA' contactor will not pick-up until the engine's lubrication system has been pressurized.

2. Starter Motors

Function: crank the engine flywheel fast enough to start the engine

Operating features: The 32 V starter motors are wired in series. The engine speed switch (ESS) will disengage the engine cranking when the engine reaches the set speed (400 rpm).

3. Starter Motor Solenoids

Function: these magnetic switches:

- engage the starter motor pinion with the ring gear
- Both starter motor solenoids must pick-up to energize Starting Contactor (ST), which in turn closes the high current starter motor circuit.

3.3 Engine Fuel System

This section describes the location, function and operating features of each component of the engine fuel system.

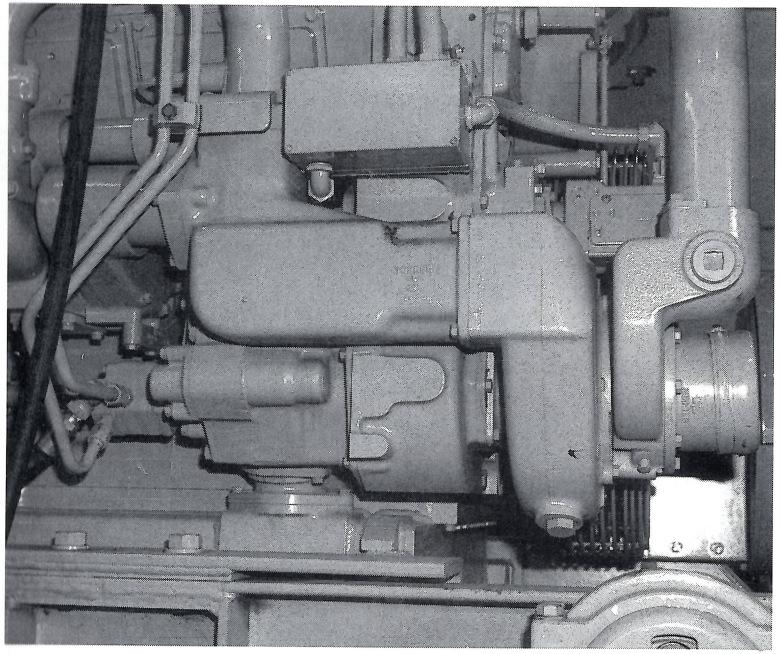


Figure 3-5: Fuel Transfer Pump

1. Fuel Transfer Pump

Location: on the right side of the engine

Function: transfers fuel from the fuel tank, through the primary fuel filter (Fig. 3-5) and the three (3) racor element filters, to the secondary fuel filters

Caution: Watch for water in the sediment bowl. Vacuum gauge should not exceed 8 inch H_2O under full load.

Operating features: The lower shaft of the engine oil pump drives the gear type transfer pump.

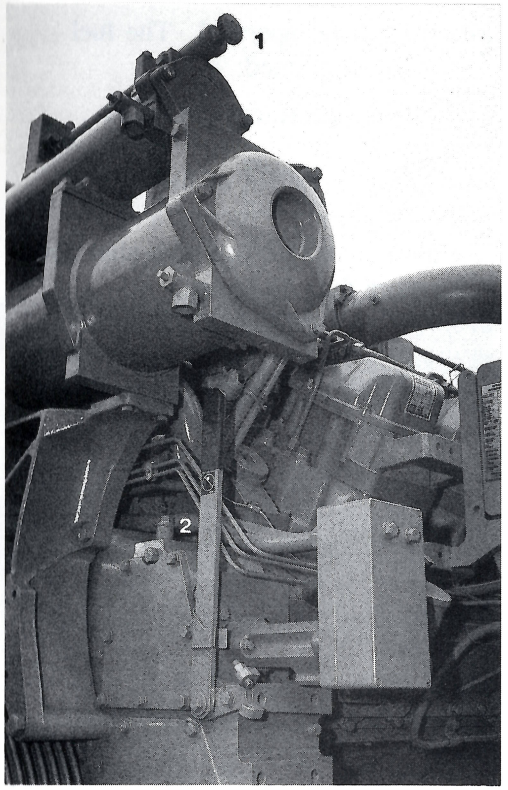


Figure 3-4: Engine Fuel System

1. Fuel Priming Pump *2. Manual Fuel Shut-Off Lever*

2. Fuel Priming Pump

Location: above the fuel filter housing

Function: primes the fuel system

Operating features:

The pump is hand operated. The fuel system **must** be primed:

- After the fuel filters have been changed
- If the unit runs out of fuel
- After repairing a suction leak
- If the locomotive has been shut down for more than 48 hours.

To Prime the Fuel System:

Turn the fuel priming pump handle knob counterclockwise. Operate the fuel priming pump until the air in the fuel system is pumped through the fuel return line to the fuel tank, or until there is resistance to moving the priming pump.

3. Manual Fuel Shut-Off Lever

Location:

left side on the front of the engine, below the lube oil filter housing

Function:

overrides the governor control of the engine

Operating features:

This shutdown moves the fuel control linkage to the fuel-off position.

Caution: The manual fuel shut-off lever does not shut off the air inlet.

3.4 Engine Cooling System

This section describes the location, function and operating features of each component of the engine cooling system.

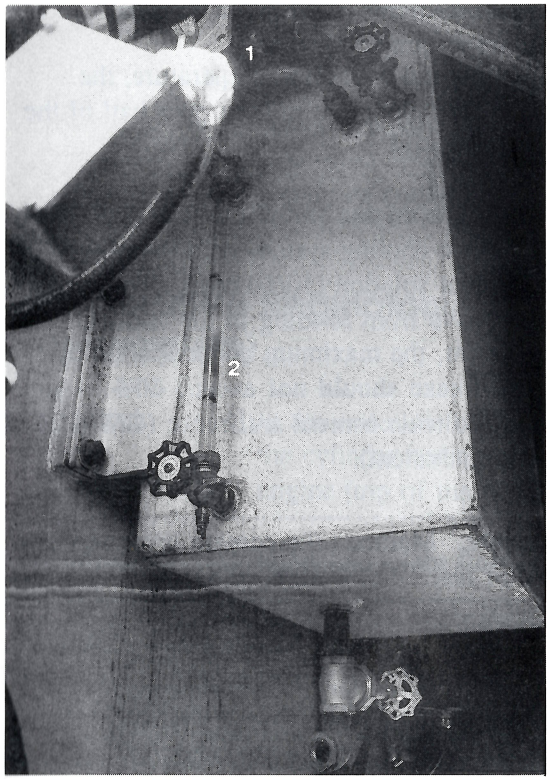


Figure 3-6: Coolant Level Sight Glass and Low Coolant Shut Down

Coolant Level Sight Glass

Location: left side of the engine between the radiator and engine room compartment

Function: shows the level of engine coolant

Operating features: At normal operating temperature, the coolant should be in the upper half of the sight gauge.

To Add Coolant: Stop the engine and allow it to cool down. Fill the cooling system with the proper coolant solution (50/50 mix). To prevent deposits from forming in the cooling system, the maximum concentration of antifreeze **should not** exceed 60%. Use low silicate content antifreeze (GM 6038M or equivalent).

Note: Maintain the coolant level to the full mark on the sight glass.

Low Coolant Shut Down

Location: on the expansion tank on the left side of the engine (near the fan compartment)

Function: shuts down the engine when the coolant level is below the minimum level to prevent engine overheating or damage

---

Note: Coolant must be added to the expansion tank to clear or reset the shutdown condition.

Temperature Regulators (Thermostats)

Location: in the water distribution manifold between the cylinder banks at the free end of the engine (top of the block)

Function: regulate coolant flow

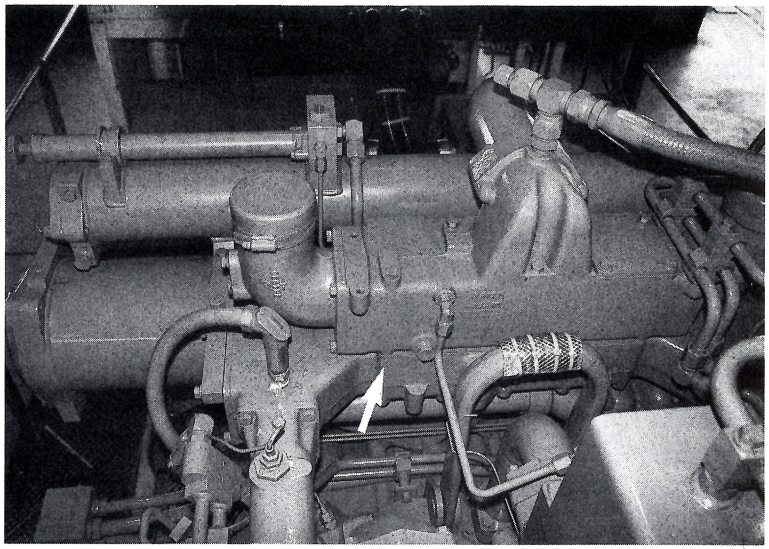


Figure 3-7: Temperature Regulators

Operating features:

The regulator housing has an upper and lower flow section and uses 4 temperature regulators. The sensing bulbs of the temperature regulators are in the coolant in the lower section of the housing. When the regulators are closed, cold coolant flows through the lower section of the housing and through the bypass line back to the water pump inlet. As the coolant temperature increases, the regulators start to open. Coolant flow in the bypass line is

restricted and the coolant flows through the outlets to the radiators.

Radiator Cooling Fans

Location:

rear end of the locomotive, above the radiators

Function:

cool the radiator when the engine coolant temperature is too high

Operating features:

Two AC radiator cooling fans are controlled by two **Immersion Type** thermostats that respond to the temperature of the engine coolant entering the radiator. These thermostats are set at two different temperatures, 180 F (low) and 190 F (high), for two stages of cooling. One fan goes on when the coolant reaches 180 F. The second fan goes on if the coolant reaches 190 F.

The Fan Cycling Relay (FCR) cycles the fan operations so each fan operates for the same number of hours.

The radiator fan control circuit allows the fans to be turned ON and OFF manually. Two manual fan control switches are mounted on the outside of the AC Cabinet. (See Fig. 3-9)

Air Compressor

Location: Radiator Compartment

Function: The air compressor is driven by an AC induction motor. The motor is attached directly to the compressor and runs approximately at one half the speed of the engine. Three phase electrical power for the motor is supplied by the Auxiliary Alternator.

The loading and unloading of the compressor is controlled by the compressor control switch. When main reservoir air pressure drops below 130 psi, the compressor control switch closes and energizes the compressor magnet valve. The valve removes the air from the unloader valves and allows the compressor to pump air. When air pressure in the main reservoirs reaches 140 psi the compressor control switch opens and de-energizes the magnet valve, which puts the

air on to the unloader valve to unload the compressor.

Note: The compressor will not load until the compressor oil pressure is above 5 psi. If the oil pressure does not build to 5 psi within 90 seconds after the compressor lis started, the compressor control breaker shuts down the compressor.

3.5 AC Cabinet

The AC Control Cabinet is in the radiator compartment on the right-hand side of the engine. The following tables describe the location, function and operating features of each of the breakers, contactors, fuses and switches located inside and outside the AC Cabinet.

Inside

The following equipment is located inside the Control Cabinet.

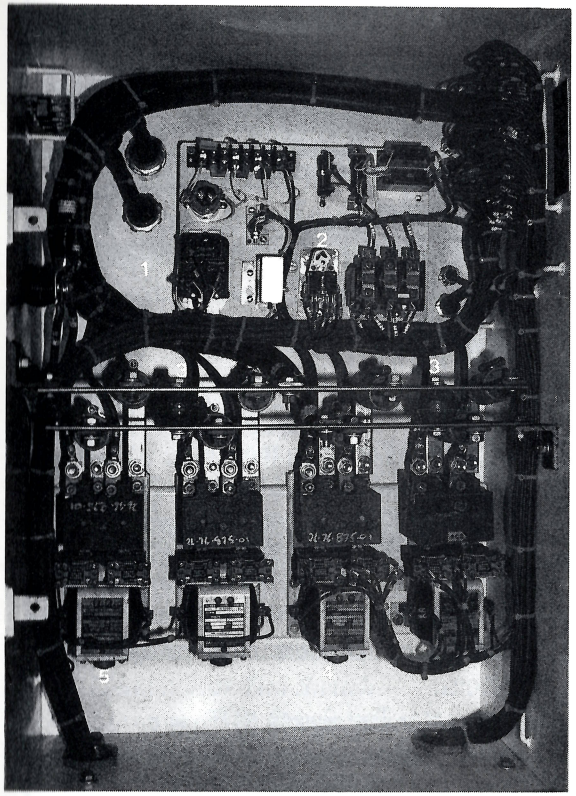


Figure 3-8: AC Control Cabinet - Inside

1. *Compressor Control Relay*
2. *Fan Cycling Relay (FCR)*
3. *Fuses*
   a. *Air Compressor*
   b. *Radiator Fan*
4. *Radiator Fan Contactors (FC1 and FC2)*
5. *Compressor Contactors (CC1 and CC2)*

Equipment	Function
1. Compressor Control Relay	When picked up, allows the compressor to pump air.
2. Fan Cycling Relay (FCR)	Alternates the fan operation so that each radiator fan operates for the same number of hours.
3. Fuses a. Radiator Fan Fuses b. Air Compressor Fuses	Two 200 A fuses protect each radiator fan motor. Four 200 A fuses protect the air compressor motor.
4. Radiator Fan Contactors (FC1 and FC2)	Activate the radiator cooling fans. One contactor picks up when the engine coolant reaches the low temperature range (180°F). The second contactor picks up when the coolant reaches the high temperature range (190°F).
5. Compressor Contactors (CC1 and CC2)	Activate the compressors under the following conditions: • Compressor Test Switch (CTS) is in manual position • Compressor Control Switch (CCS) closes when there is a demand for air.

Outside

The Compressor Test Switch, the Low and High Temperature Test Switches and the Compressor Control Switch are located outside of the AC cabinet.

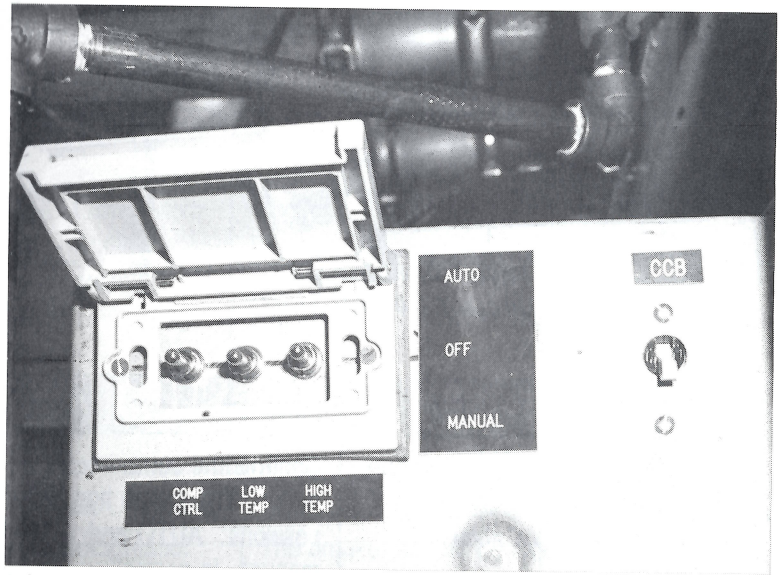


Figure 3-9: Test Switches

1. *Compressor Test Switch*
2. *Low and High Temperature Test Switches*
3. *Compressor Control Breaker*

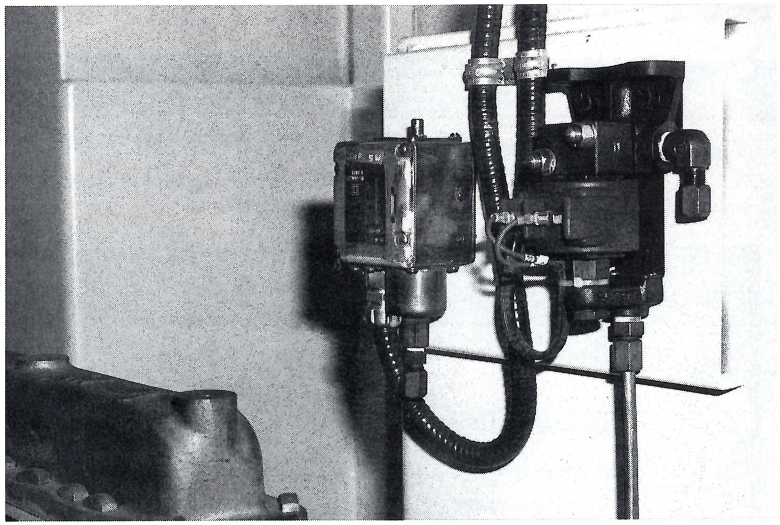


Figure 3-10: Compressor Control Switch

Switch	Location	Function
1. Compressor Test Switch	on the outside of the AC Cabinet	Controls the compressor motor. The switch has two positions: AUTO and manual. In normal conditions, the switch must be on AUTO. If the switch is on MANUAL, the compressor motor runs continuously. In this mode, the compressor control switch still controls the loading and unloading of the compressor.

Switch	Location	Function
2. Low and High Temperature Test Switches	on the outside of the AC Cabinet	Control the radiator fans. The switches have three positions: ON, OFF and AUTO. In normal conditions, the switches must be on AUTO. If the switches are ON, the radiator fans run continuously.
3. Compressor Control Switch	rear wall in the Radiator Compartment (Fig. 3-10)	This air operated switch activates the Compressor Unloader Magnet Valve when air pressure in the main air reservoir tanks drops below 130 psi. This electric solenoid valve pneumatically operates the compressor unloader.
4. Compressor Control Breaker	The breaker should be ON (up) at all times.	

3.6 Engine Equipment

This section describes the location, function and operating features of the equipment on the engine.

Turbochargers

Location: rear of the engine (cab end)

Function: provide pressurized combustion air to the intake manifold

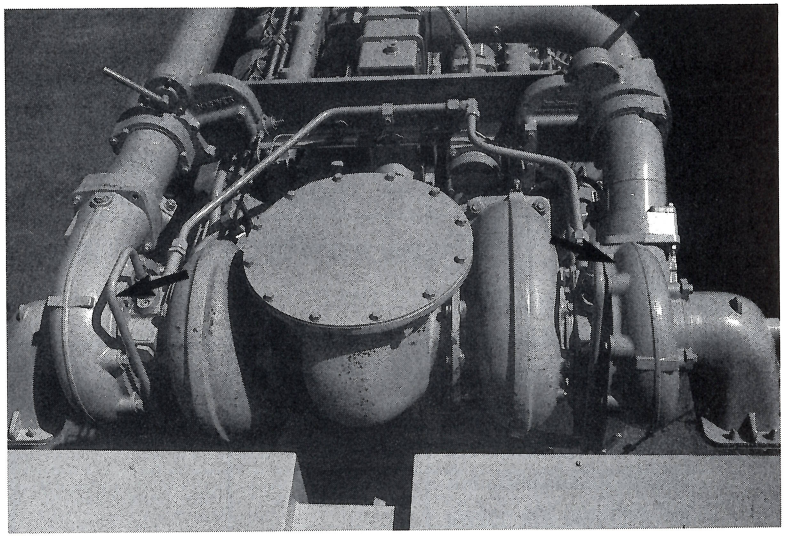


Figure 3-11: Turbochargers

Operating features: The two turbochargers have a turbine wheel and a compressor wheel that turn at speeds up to 70,000 rpm.

Pumps and Rack Actuator

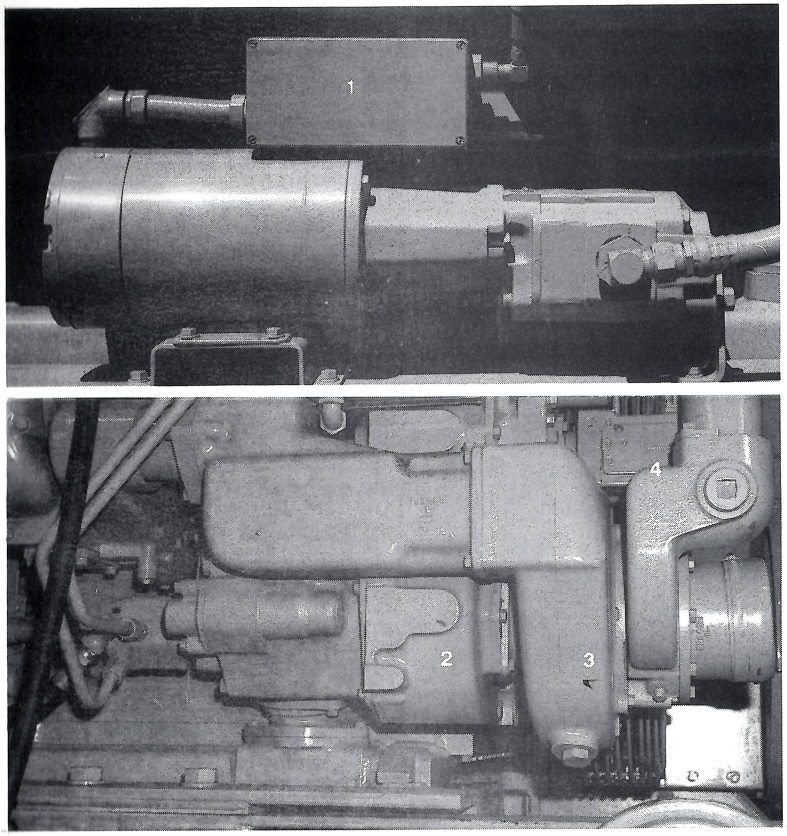


Figure 3-12: Pumps and Rack Actuator

1. *Pre-lube Oil Pump*
2. *Lube Oil Pump*
3. *Water Pump*
4. *Rack Actuator*

1. Pre-Lube Oil Pump

Location: right side of the engine

Function: pressurize the engine Lube Oil System

Operating features: The engine pre-lube system is electrically operated and is pressurized before every engine start cycle.

Note: Starters will not engage unless the lube oil system is pressurized.

2. Lube Oil Pump

Location: right side of the engine

Function: pumps oil from the oil pan to the engine

Operating features: The front gear train drives the three pump gears. The pump draws oil from the oil pan through a suction bell and elbow. The suction bell has a screen to clean the oil and to protect the pump.

The oil pump has a relief valve that controls the pressure of the oil from the pump.

3. Water Pump

Location: right side at the front end of the engine

Operating features: Coolant goes into water pump inlet and flow is divided at the outlet of the water pump. Part of the coolant flow is sent to the aftercooler and through the engine cooling passages, while most of the coolant is sent through the oil cooler. The water pump is driven by a gear on lube oil pump.

4. Rack Actuator

Function: mechanically controls the fuel rack linkage

Operating features: The Rack Actuator is an electro-hydraulic device that is engine driven. Based on an electrical signal from the PEEC Electronic Governor control box, and using the engine oil supply, the device controls the fuel rack linkage with hydraulic power.

Air Damper Valves

Location: the engine has two air damper valves, one on each bank, on the Inlet Air Manifolds in front of the turbos

Function: shut down the engine by cutting off the intake air supply under the following conditions:

- Engine overspeed
- Emergency STOP button is pushed. (MU Shutdown Button)

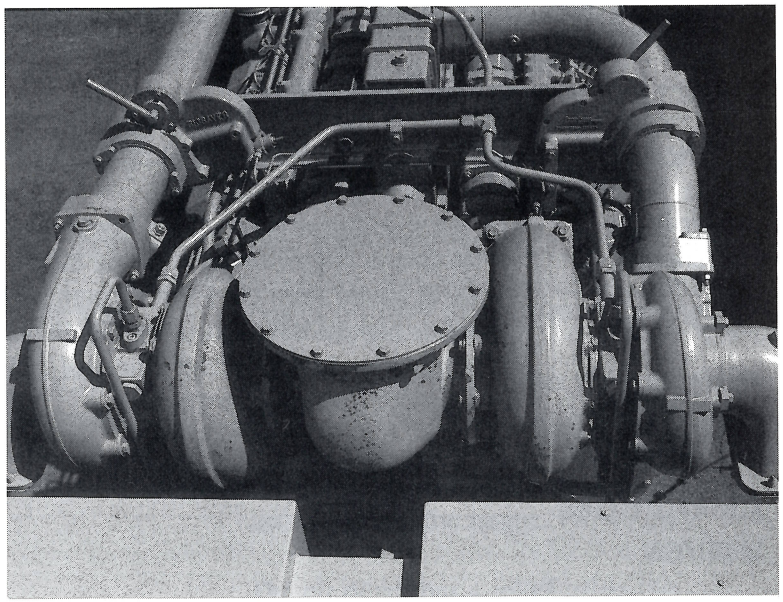


Figure 3-13: Air Damper Valves

Engine Crankcase Oil Level Gauge (dipstick)

Location: left side of the engine

Function: measures the engine oil level

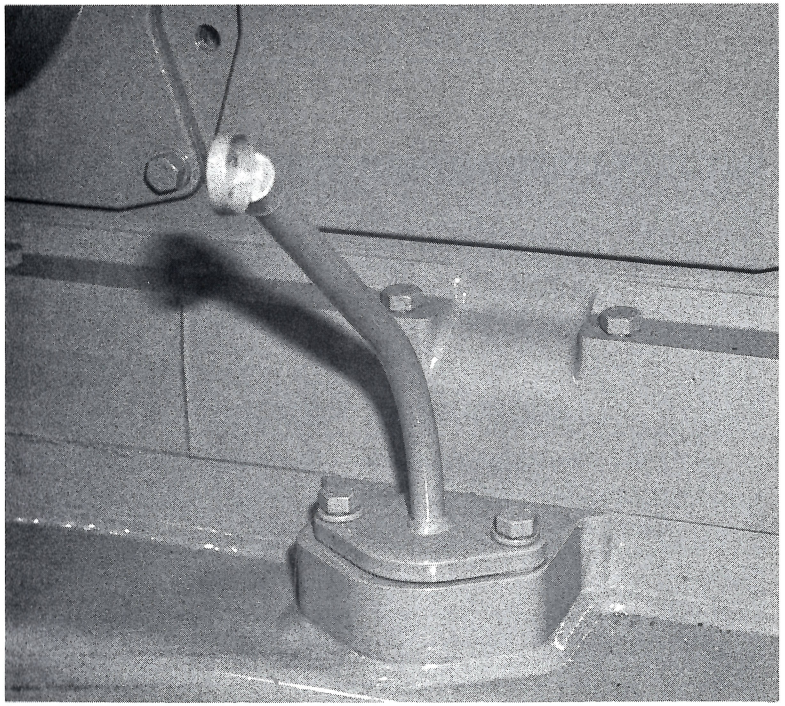


Figure 3-14: Engine Crankcase Oil Level Gauge (dipstick)

Operating features:

Check the engine oil level either with the engine running at idle speed (600 RPM) or with the engine shut down. Maintain the oil level between the add and full mark. If necessary, add oil through the fill tube.

Caution: Do not fill the crankcase above the FULL mark on the dipstick.

3.7 Engine Mounted Safety Switches

The following switches are mounted on the engine block on the right side of the engine.

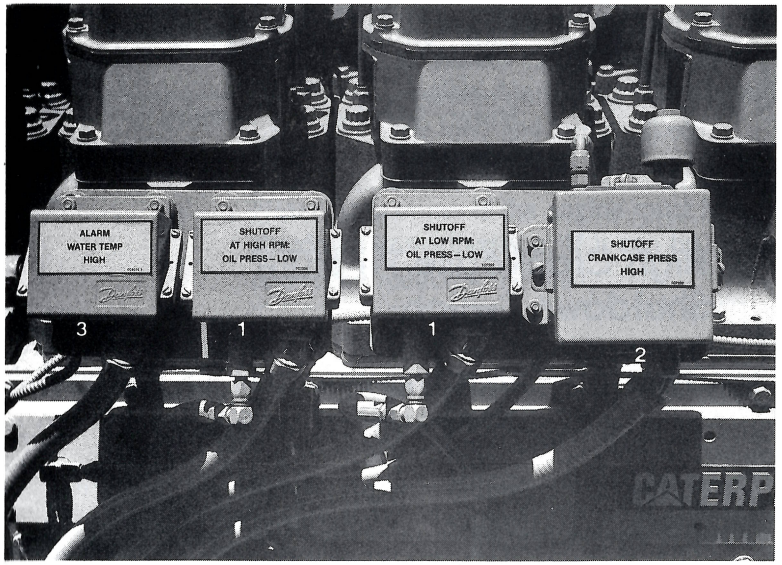


Figure 3-8: Engine Mounted Safety Switches

1. *Low Oil Pressure Shutdown Switches*
2. *High Crankcase Pressure Shutdown Switch*
3. *Engine Coolant Over Temperature Switch*

1. Low Pressure Shutdown (Low & High RPM) Switches

Function: shut down the engine if the oil pressure is too low

Operating features: The oil pressure switches sense oil pressure at the bearing oil gallery. The shutdown is set to trip at 23+/-3 psi at low RPM (less than 1000 RPM) and 45+/-3 psi at high RMP (greater than 1000 RPM).

Note: Switches may re-close at 7 to 9 psi below actual trip point.

2. High Crankcase Pressure Shutdown Switch

Function: shuts down the engine if the crankcase pressure exceeds 2.0 inch H_2O

Operating features: Rapid changes in crankcase pressure indicate piston, ring and liner problems. Typical operating pressure readings should be 1.0 inch H_2O to 1.5 inch H_2O. The crankcase pressure annunciator will indicate when crankcase pressure exceeds 2.0 inch H_2O, and the engine will shut down.

3. Engine Coolant Over Temperature Switch

Function: shuts down the engine if the engine coolant temperature exceeds the boiling temperature for the pressurized system

Operating features: The engine coolant temperature may vary according to load, but should never exceed the boiling temperature for the pressurized system. The engine coolant temperature range is 160°F to 210°F. If the coolant temperature continues to rise, the High Water Temperature Alarm will activate and will reduce the load and engine speed.

Note: Determine if the engine must be shutdown immediately or if it can be cooled by reducing the load.

Chapter 4
Operation

4.0 Introduction

This chapter briefly describes the following procedures recommended for operating the locomotive:

- Preparing for service
- Starting the engine
- Placing units on line
- Precautions to take before moving the locomotive
- Handling a light locomotive
- Coupling to train
- Other routine operating procedures and special features, such as dynamic braking, auto start and safety devices.

The procedures are presented in sequence and do not contain detailed explanations of equipment location or function.

4.1 Preparing for Service

This section describes the inspections the operator must make when preparing the locomotive for service.

Ground Inspection

Check locomotive exterior and running gear for:

- Fuel, oil, lube oil, water or air leakage
- Loose or dragging parts
- Proper positioning of all angle cock and shut-off valves
- Air cut-in to truck brake cylinders
- Satisfactory condition of brake shoes
- Adequate fuel supply.

In a multiple consist, check for:

- Proper hose connections between units
- Proper installation of control jumper cables between units.

Lead Unit Cab Inspection

On the lead or control unit, make sure the main battery and ground relay switches are **closed**. Check the control locations described in Chapter 2.

Circuit Breaker Panel

Check that the following circuit breakers and switches are ON at all times:

- DB - Cut-Out Switch
- FBB - Filter Blower Motor Breaker
- RB - Radio Breaker
- W/WCB - Water Cooler and Whistle
- PPB - Pre-Lube Pump
- MB1 - Main Battery Positive Breaker
- MB2 - Main Battery Negative Breaker
- XAFB - Auxiliary Alternator Field Breaker
- Head Light Breaker
- LPB1 and LPB2 Cab Lights.

The following circuit breakers and switches should only be ON as required:

- HL - Headlight Set-Up Switch
- Slug Auxiliary Power Breaker (ON only when working with a slug)
- WHB - Window Heater Breaker
- ECHB1 - Baseboard Heater Breaker, engineman's side
- ECHB2 - Baseboard Heater Breaker, trainman's side
- HPB - Hot Plate Breaker
- LPB1 - Engine Room Lights Breaker.

Engine Control Switch (ECS)

Check that the engine control switch is in IDLE.

Operators Control Stand

Breakers and Switches

The following breakers must be ON at all times:

- Fuel Pump Breaker
- Control Breaker
- DBB - Dynamic Brake Breaker.

The following breakers and switches should only be ON as required:

Breaker/Switch	Switch ON...
Generator Field	as required.
SOS	when working with a slug.
Main	for mainline operation.
Yard	for yard operation only.

Air Brake

Check that the following air brake valves are in the correct position:

Valve	Position
Independent Brake Valve	Applied
MU2A Valve	Lead
Auto Brake: • Cut-Out Cock • Brake Valve Handle	Freight or Pass Release

Engine Room Inspection

Rad Compartment

- Check compressor lube oil level.
- Check that the compressor cut-out cock is in the AUTO position.

Engine Room

- Check coolant level.
- Check crankcase lube oil level (lube oil dipstick is located on the left side of the engine).

- Check that the engine top deck, air box and oil pan inspection covers are in place and securely closed.
- Check that the engine intake air damper valves are in SET position.

Trailing Unit Cab Inspection (CAT)

Operators Control Stand

Check that the following air brake valves are in the correct position:

Valve	Position
Automatic Brake Valve	Handle-Off (remove handle)
Independent Brake Valve	Release
MU2A Valve	Desired position for trailing unit operation
Cut-Off Valve	Out

Check that the following locomotive control breakers and handles are in the proper position:

Breaker/Handle	Position
Control Breaker	OFF (down)
Fuel Pump Breaker	OFF (down)
GF Breaker	OFF (down)
Dynamic Brake Handle	O (off)
Reverser Handle	Neutral, then removed from the controller to lock the other handles
Throttle Handle	IDLE

Circuit Breakers

- Turn ON (up) all breakers with red labels in the control cabinet.
- Move the engine control switch (ECS) to the run position to place the unit on-line.
- If the unit is coupled to another unit that has its air brakes and hand brake applied, release the handbrake.

4.2 Starting the Diesel Engine

Once the preceding inspections are complete, the engine is ready to start. This section describes the procedure for starting the engine.

Starting controls are located in the cab and on the left side of the engine next to the gauge panel.

Lead Unit

To start the engine:

1. Check the oil level in the engine and air compartments.
2. Check the coolant level.
3. Check that the engine air intake damper valves are in the SET position.
4. Check that the main battery switch is CLOSED.
5. Check that the ground relay knife switch is CLOSED.
6. Check that the MU shutdown button is in SET position.
7. Check that the following circuit breakers on the electrical cabinet are ON (up):
   - FFB
   - W/WCB
   - LPB1
   - LPB2

- PPB
- MB1
- MB2.

8. Move the ECS switch into the IDLE position.
9. Turn ON the Fuel Pump and Control breakers on the control stand.
10. Check that the GF breaker is OFF (down).
11. Press and release the start switch. The pre-lube pump light comes on. After a few seconds, the light will get brighter. The engine is ready to start.
12. Press and hold the engine start switch until the engine starts. If the engine does not start, refer to Chapter 5, Troubleshooting.

Trailing Units

Follow the above procedure to start the engine in trailing units.

After starting the engine, turn OFF the Control and Fuel Pump breakers.

4.3 Placing Units on the Line

Once the diesel engine has been inspected and started, move the engine control switch (ECS) to the RUN position to place the unit on line.

Caution:
Make sure the throttle handle on all units is in the IDLE position before placing any unit on line.

4.4 Precautions Before Moving Locomotive

Before attempting to move the locomotive under its own power, check that:

- The main reservoir is charged to normal operating pressures (130-140 psi)
- The air brakes are working properly
- The handbrake is released and there is no blocking under the wheels
- The unit is safe to move.

Caution:
The engine water temperature should be 120 F or higher before full load is applied to the engine. After idling at ambient temperature below 0 F, increase to full load gradually.

4.5 Handling Light Locomotive

This section describes the procedure for handling the locomotive once it is on line and the above precautions have been taken.

1. Turn the Gen Field Switch ON (up).
2. Turn the headlight and other lights ON as needed.
3. Insert the reverser handle and move it to either forward or reverse.
4. Check operation of safety devices as per General Operating Instruction.
5. Release the air brakes.
6. Release the hand brake.
7. Move the throttle to RUN 1, 2 or 3 to set the track speed.

Note:
Engine response to throttle movement is almost immediate. There is little delay in power build up.

8. Move the throttle to the IDLE position before coming to a dead stop.

9. Do not move the reverser handle until the locomotive is completely stopped. To change the direction of travel, wait until the locomotive is completely stopped. Then move the reverser handle in the opposite direction.

4.6 Coupling

This section describes the procedures for coupling:

- Locomotive units
- The locomotive to the train
- Locomotive units for dynamic braking in mixed consists.

Coupling Locomotive Units

To couple locomotive units together for multiple unit operation:

1. Remove the reverser handles from all trailing units to lock the controls.
2. Couple and stretch units to make sure the couplers are locked.
3. Install control cable between units.
4. Connect air hoses between units.
5. Open required cut-out cocks on the air hoses on both units.
6. Perform the ground engine room and engine inspections described in section 4.1.
7. Position cab controls for trailing unit operation as described in sections 4.1 and 4.2.

Coupling Locomotive to Train

To couple the locomotive to a train, follow the procedure described above for coupling locomotive units.

Note:
Before coupling the air charging line (trainline) to a car, make sure the hoses are free from all foreign material.

Throttle

How quickly the throttle should be advanced depends on the type of locomotive and train involved. In general, however, advance the throttle one notch at a time to prevent slipping.

The load indicating meter provides the best guide for throttle handling when accelerating a train. As the throttle advances, the pointer moves toward the right (increased amperage). As soon as the engine absorbs the increased power, the meter begins moving toward the left.

For maximum acceleration without slipping, advance the throttle one notch each time the meter pointer begins moving toward the left, until the throttle is in position 8 (full power).

Dynamic Braking in Mixed Consists

Locomotives equipped with dynamic brakes control breaking strength by using the electric potential from the brake control rheostat to control excitation of the main alternator field.

This electric potential flows through a trainline wire to control the dynamic braking strength of all units in a consist that are equipped with a potential line brake control. With this feature, the total braking effort of a multi-unit consist can become quite high.

4.7 Routine Operating Procedures and Special Features

Draining Air Reservoirs and Strainers

Drain the air reservoirs at least once each day, even if the equipment has automatic drain valves.

Traction Motor Cut-Out Switch

Use the traction motor cut-out switch to isolate a defective traction motor.

Caution:
Move the engine control switch to the IDLE position before operating the motor cut-out switch.

The power control system automatically limits power to avoid overloading the operating motors. The cut out motors continue to rotate as the train moves.

Check that all wheels rotate freely before operating with a cut out motor.

Air Braking with Power

When braking with power:

- Remember that for any given throttle position, the pull of the draw bar rapidly increases as the train speed decreases. To prevent this pull from becoming great enough to part the train, reduce the throttle as the train speed decreases.

  The amperage on the load meter indicates the pull of the locomotive. To maintain a constant pull on the train during a slow down, keep a steady amperage on the load meter by reducing the throttle a notch whenever the amperage starts to increase.
- Keep the independent brakes fully released during power braking.
- The throttle **must** be in IDLE before the train comes to a stop.

Warning:
Heavy power braking can cause serious damage to electrical rotating equipment.

Power at Stall

Do not hold the train at a standstill on a grade or with the brakes applied and the throttle open for power. It may cause extensive damage to the traction motors.

Operating Over Rail Crossing

When operating the locomotive at **speeds over 25 mph**, reduce the throttle to position 4, at least 8 seconds before the locomotive reaches the rail crossing.

When operating the locomotive in Run 4 position or lower, or at **speeds less than 25 mph**, move the throttle to the next lowest position at least 8 seconds before the locomotive reaches the rail crossing.

Advance the throttle only after all units of the consist have passed over the crossing. This ensures that the motor and generator voltages are at a safe level before the mechanical shock that occurs at rail crossings is transmitted to the motor brushes.

Running Through Water

Warning:
Never operate the locomotive through water deep enough to touch the bottom of the traction motors. Water deeper than 2.5" above the rail is likely to cause traction motor damage.

When passing through water on the rails, exercise every precaution and always go very slowly. Never exceed 2 to 3 mph.

Wheel Slip

This section describes the wheel slip correction system and what to do if the wheel slip light is on continuously during locomotive operation.

Wheel Slip Correction

The wheel slip correction system functions automatically. The operator does not have to take any action.

To correct wheel slip, the system instantly reduces locomotive power and initiates automatic sanding functions to correct wheel slip. After correcting the slip, the system continues a timed application of sand while smoothly restoring power.

The wheel slip control system reacts so rapidly to correct minor slips that the wheel slip light seldom comes on except to indicate severe slips.

During the correction process, the load current meter may indicate a steady reduction of load current to a level below normal at full throttle for a given speed. Do not misinterpret this as a fault. It is simply the wheel slip control system doing its job and maintaining power at a level within the adhesion conditions established by the track and grade.

Note:
Whenever possible, operate at full throttle on grades. Reduce the throttle during wheel slip only when:

1. Repeated wheel slips cause severe lurching that may pull the train apart. (In the event of severe slipping, use a helper or take the train up the hill in two parts.)
2. In unusual conditions, simultaneous wheel slips may occur at low speed or stall. In this situation, either apply sand to the rail or reduce the throttle manually.

Wheel Slip Light

If the wheel slip light blinks on and off persistently or is on continuously during locomotive operation, a pair of wheels may be sliding or there may be circuit problems. If this happens, **immediately stop** the locomotive and determine the cause.

The wheels may be sliding due to:

- Locked brake
- Damaged traction motor bearings
- Broken pinion or gear teeth.

Repeated ground relay tripping, accompanied by unusual noises may indicate serious traction motor trouble that should be investigated at once.

Do not allow any unit that must be isolated due to repeated wheel slip or ground relay action to remain in a locomotive consist **unless it has been absolutely determined that all of its wheels rotate freely.**

Locomotive Speed Limit

The locomotive speed limit is the maximum speed at which the motor armature can rotate. This speed is determined by the gear ratio. Exceeding this maximum speed can result in serious damage to the traction motors.

The ratio is expressed as a double number. For example, if the ratio is 74:18, the 74 indicates the number of teeth on the axle gear, and 18 indicates the number of teeth on the traction pinion motor gear. Since the two gears are meshed together, the motor armature turns approximately four times for a single revolution of the driving wheels. Therefore, for this gear ratio, **the maximum speed at which the locomotive can operate safely works out to 65 mph.**

Mixed Gear Ratio Operation

If the units of the consist have different gear ratios, the maximum speed limit for the consist is set by the unit with the lowest maximum speed.

The minimum speed limit is set by the minimum continuous speed (or maximum motor amperage) for units with established short time ratings.

Dynamic Braking

Dynamic braking will slow the train in many phases of locomotive operation. It is particularly valuable when descending grades, reducing the necessity for using the air brakes.

Depending on the locomotive gear ratio, dynamic braking is most effective at speeds between 22 and 30 MPH. At speeds above this range, effectiveness decreases as speed increases. Therefore, start dynamic braking **before** the train speed becomes excessive. While in dynamic braking, do not let the speed "creep" up by handling the brake carelessly.

To operate dynamic brakes:

1. The reverser handle must be in the direction the locomotive is moving.
2. Move the throttle to IDLE. Hold it there for 10 seconds before proceeding.

Warning:
Wait 10 seconds before moving the braking handle to SET UP.

3. Move the braking handle to SET UP. This establishes the dynamic braking circuits. The load current meter may indicate a slight amount of braking effort.
4. After the slack is bunched, move the dynamic braking handle to control braking strength. As the handle is moved out of SET UP, the engine RPM increases above a certain brake level demand to keep the traction motors cool (600 rpm in DB1-3, 1000 rpm in DB4-8).
5. Increase the braking effort by slowly moving the handle to FULL 8. Maximum braking current, limited to 895 amperes, can occur over a wide range of handle position. This range allows braking effort to increase as the train speed increases.

When conditions reduce the maximum allowable current, dynamic braking tends to hold the train speed relatively constant for a given braking handle position.

6. Since the braking strength is regulated automatically, the warning light on the controller should seldom indicate excessive braking current. If the brake warning light does flash on, stop moving the braking handle until the light goes out.
7. If the light does not go out after several seconds, move the braking handle back slowly until the light goes out. Once the light is out, slowly advance the handle to increase braking effort.

Note:
The brake warning light is "trainlined." A warning is given to the lead unit if any unit in the consist is generating excessive current in dynamic braking. Therefore, do not wait any longer than two or three seconds after the light comes on before reducing braking effort, regardless of the load indicating meter or braking handle position (which may be less than maximum).

If brake warnings are repeated, take the locomotive out of dynamic braking. Move the dynamic brake cut-out switch on the engine control panel of the affected unit to CUTOUT. The consist will operate normally under power and during dynamic braking, but will have reduced total braking effort.

Dynamic Brake Wheel Slip Control

During dynamic braking, each group of two traction motors is connected in parallel with each separate pair of dynamic braking resistor grids. A center point on both resistor grids is electrically common with each other and with the conduction that ties the two sets of traction armatures in series. As a result, each generating traction motor armature independently dissipates energy in separate halves of the DB resistor grids.

As in motoring, each traction motor armature has a separate transductor that senses current. The analog voltage, developed in the transductor input module, is proportional to the armature or (DB grid current). An imbalance in these voltages indicates a differential wheel slip. The wheel slip panel detects the imbalance and automatically corrects the wheel slip.

Unlike the motoring wheel slip correction system, the dynamic braking system only detects differential wheel slips. In motoring, the system can detect a synchronized wheel slip (all wheels slip at the same rate). However, this is extremely difficult to detect in dynamic braking. Therefore, never use the independent brake in combination with the dynamic brake since it can result in skidded wheels.

Isolating a Unit

When operating under power, units may be isolated at any time. It is up to the operator to decide when it is necessary.

Units can not be isolated when in dynamic braking. Move the brake handle to OFF to get out of dynamic braking. Then move the isolation switch to IDLE to eliminate dynamic braking on that unit. When braking is resumed, all other units will function normally.

Changing Operating Ends

When the locomotive consist includes two or more units with operating controls, use the following procedure to change from one operating end to the opposite end on locomotives equipped with 26L brakes.

On the end being cut out:

1. Move the automatic brake valve handle to service position and make a 20-pound reduction.
2. After brake pipe exhaust stops, move the cut-off valve to OUT.
3. Fully release the independent brake.
4. Move the MU valve to the TRAIL position required by the brake equipment on the trailing units.
5. Move the automatic brake valve to OFF. (On some locomotives, the handle is removable.)
6. Move the dynamic brake handle to OFF.
7. Move the throttle to IDLE.
8. Turn all switches on the controller OFF (down). Make absolutely sure the control, fuel pump and generator field switches are OFF (down).
9. On the engine control panel, move the headlight control switch to the proper position for trailing unit operation. Turn other switches ON as needed.
10. At the circuit breaker panel, the following breakers should be ON:
    - SXPB
    - FBB
    - FARCO
    - WHB

- ECHB1
- ECHB2
- ECHB3
- ECHB4
- RB
- HPB
- W/WCB
- LPB1
- LPB2
- PPB
- SPB
- MB1
- MB2
- XAFB
- HCB

11. After completing the above steps, close all doors and windows.

On the end being cut in:

1. Check that the generator field switch on the controller is OFF (down).
2. Insert the reverser handle and leave in NEUTRAL.
3. Insert the automatic brake valve handle if it has been removed. Move the handle to the suppression position to nullify any safety control, overspeed or train control.

4. Insert the independent brake valve if it has been removed. Move the handle to the full independent application position.
5. Move the MU valve to LEAD.
6. Move the cut-off valve to either FRT or PASS, depending on the make up of the train.
7. Check that all circuit breakers on the circuit breaker panel are in the ON position as needed.
8. On the engine control panel, move the headlight control switch to the proper position. Turn other switches ON as needed.
9. On the controller, turn the control, fuel pump and generator field switches ON (up). Turn other switches ON as needed.

Freezing Weather Precautions

Because the system uses engine thermostats, the radiators will freeze in cold weather operation. If freezing temperatures are expected, check that the cooling system has adequate protection against freezing. A 50/50 solution of permanent-type antifreeze gives protection below -20°F (-29°C).

Draining the Cooling System

The cooling system is charged with permanent-type antifreeze. Consult a Mechanical Representative before draining the cooling system.

Towing the Locomotive in the Train

The procedure for towing a locomotive in a consist is the same for dead and idling locomotives.

To tow a locomotive in a train consist:

1. Drain all air from the main reservoirs and air brake equipment.
2. Move the MU valve to DEAD.
3. Move the cut-off valve to OUT.
4. Move the independent brake valve handle to RELEASE.
5. Move the automatic brake valve handle to HANDLE OFF.
6. Open the cut-off cock (90° to pipe) to cut in the dead engine feature.

Leaving the Locomotive Unattended

When leaving the locomotive unattended with the engine running:

1. Observe **all** railroad safety precautions.
2. Move the ECS to IDLE.
3. Turn the G.F. switch OFF.

4. Move the throttle to IDLE.
5. Move the dynamic brake handle to OFF.
6. Remove the reverser handle from the controller to lock the controls.
7. Move the independent brake handle to the full application position.
8. Make full service application.
9. Inform the Train Dispatcher.

Autostart Panel

Set the locomotive for Autostart whenever it is not required for service. For example, if it will be sitting in a yard or on a siding for a period of time. The Autostart panel automatically starts the engine, self-loads it until the engine is hot, then shuts it down.

Autostart continues as longs as:

- The system remains in Autostart
- The engine has fuel
- The engine does not suffer any fault
- There are no locomotive faults.

Warning:
The Autostart panel sounds an alarm for thirty (30) seconds before starting the engine. If anyone is in a dangerous position when the alarm sounds, either:

- Move the person out of danger, or
- Turn the Engine Control Switch (ECS) to any position other than AUTOSTART.

To set Autostart:

1. Check that all control circuit breakers are ON.
2. Move the ECS to AUTOSTART.
3. Wait until the Autostart light flashes (1/2 seconds on, 1/2 seconds off). This give the PLC time to "wake up" and lets the system perform all its normal checks.
4. Press the Autostart push-button. The light stops flashing and remains on. If the light continues to flash, press the button again. If the light still flashes, the PLC is not accepting the Autostart command, most likely due to faulty wiring or engine/locomotive faults.

Note:
Autostart can be initiated when the engine is either stopped or running.

To turn Autostart off:

1. Move the ECS out of AUTOSTART.

Note:
This the only way to turn Autostart off. If the engine is running and under test when the switch is moved out of AUTOSTART, the engine automatically goes to IDLE. In an emergency, the MU shutdown will also turn off Autostart.

Autostart Indicating Light

The Autostart pushbutton is also an indicating light. It indicates any of the following.

If Light Is...	Indicates
Off	Autostart is off or the light is burned out.
Flashing 1/2 second on, 1/2 second off	Autostart is in the "wake up" mode.
Flashing rapidly	A fault has been detected. Autostart will not operate until it is repaired.
On	Autostart is on.

Event Recorder/ Reset Safety Device

All locomotives are equipped with Microfuel's Train Monitoring and Control System (TMACS), which is a combination event recorder and reset safety device. The event recorder logs many of the locomotive operating characteristics and stores this data in solid-state memory. The reset safety device (RSD) replaces the old "deadman pedal" and stops the locomotive should the engineman become incapacitated. Since many of the connections required for both of these systems are common, they are contained in a single cabinet and supplied from one isolated power supply.

Event Recorder

The event recorder is a microprocessor controlled unit with sufficient memory to store approximately 33 minutes of "crash" data at a 1 second rate, plus 30 hours of typical event data at a 5 second rate, plus 90 days of long term statistical data. Recording of crash data commences when the locomotive speed exceeds 0.2 MPH and ceases 10 seconds after the locomotive stops. Event data is recorded continuously.

The events currently being recorded include:

- Speed
- Throttle positions
- Direction
- Brake pipe pressure
- Brake cylinder pressure
- Horn application
- Bell application
- Emergency brake application
- Engine run
- Independent brake pressure over 15 psi
- Radio transmit
- RSD manual pushbutton
- Equalizing reservoir pressure
- Penalty brake application
- Use of self-test pushbutton
- RSD over-ridden

In addition to the above functions, there are several spare channels that allow additional items to be recorded as desired.

The event recorder contains a battery-backed, real-time clock that records the time of all event occurrences.

In normal operation, the event recorder functioning occurs without any indications. The oldest data gets written over by newer data and any data may be extracted using a portable lap-top computer. Security for the event recorder is provided so that if the power supply is turned off or if any of the cables are disconnected, the car emergency air brakes will be applied.

Reset Safety Device Operation

The Reset Safety Device system includes control circuitry in the event recorder cabinet, a control head in the cab, and a magnet valve located in the safety control pipe.

The RSD system is automatically disabled on locomotive set up for trailing air brakes, and enabled on the lead locomotive if direction is selected, or if the independent brake pressure is below 15 psi, or if locomotive speed exceeds 0.2 MPH. Once enabled, the RSD initiates a timer circuit

that is automatically reset by normal operation of any of the following controls:

- Change of throttle
- Direction
- Radio transmit
- Independent air brake application & release
- Automatic air brake application & release
- Horn application
- Bell application
- Manual reset pushbutton

If none of the above controls have been operated for a period dependent on car speed, (20 - 155 seconds) the RSD initiates the visual and audible alarms on the control head. If the engineman fails to reset the system using any one of the resets, within 20 seconds, the RSD will de-energize the overspeed magnet valve to apply the locomotive brakes at the service rate (penalty brake application).

Should the RSD experience a microprocessor failure, a simplified back-up system is provided. With this system, the reset period is fixed at 25 seconds, and resetting can only be accomplished by the Manual Reset Pushbutton. If the RSD feature needs to be disabled, an Override switch is provided on the event recorder. The use of this switch prevents the penalty

brake application but all other functioning (i.e. alarms) continues. The event recorder logs the use of this switch.

In addition to the alarms, the RSD control head contains a Test pushbutton to qualify the system, and Override and Air Brake Applied indicators.

System Disabled:

When the unit is set up for trail position or if:

- Speed is a 0 mph, and
- Reverser handle is centred, and
- Independent brake is greater than 15 psi.

System Timing:

The following table lists the time available, at various speeds, to reset the system to avoid penalty application.

Speed (mph)	Time (seconds)
0-2	20
2-8	20
	155 after reset
20	105
30	90
60	60
Backup Mode (only resets with safety push-button or foot switch)	120

Pacesetter Operation (where applicable):

Between 0.1 and 2 mph, timing allowance is 4 minutes after first reset. Greater than 2 mph, normal operation timing applies.

Penalty Recovery:

Allow 30 seconds to reset, then recover penalty application by normal operating procedures.

Self-Test Button:

Pushing this button when the system is disabled produces a test of the audible and visual alarms. This indicates that the system is fully operational.

Backup Mode:

The alarm indicator light indicates a processor failure. The Reset Safety Device continues to operate, but can only be reset manually with the push-button or foot pedal (with no change in time with speed change). Allowance time is 2 minutes, then 2 minutes of alarms.

Problems:

If the Reset Safety Device is inoperative, malfunctioning or has a broken seal, **report it immediately to the Dispatcher,** who will inform the appropriate people.

Chapter 5
Troubleshooting

5.0 Introduction

This chapter describes operational problems the locomotive may have on the road and suggests some operator responses.

5.1 Safety Devices

In case of faulty operation of almost any locomotive component, safety devices automatically do one of the following to protect the equipment:

- Completely shut down the diesel engine or eliminate a function, such as Dynamic Braking.
- Unload the diesel engine and restrict it to idle engine speed. In some instances, you may have to manually reset the safety device, but often it is automatically reset after a time delay.
- Regulate rough back-up.

5.2 Troubleshooting Tables

The following tables list common operating problems, the probable causes and suggested corrections.

Problem	Probable Cause	Suggested Corrections
Engine will not crank	• Dead batteries	Recharge or change batteries
	• Engine Control Breaker tripped	Reset breaker
	• Oil Pressure Switch for prelube pump is defective	Replace switch
	• Prelube Oil Pump defective	Replace pump
	• Engine Stop Switch stuck open	Free or change switch
	• MU (Emg. Shut-down) Button pushed in	Reset MU shutdown button and air dampers
	• Starting Relay defective	Change relay
	• Starting Motor solenoid defective	Change solenoid
	• Starting Motor defective	Replace motor

Problem	Probable Cause	Suggested Corrections
Engine will crank, but will not start	• No fuel in the fuel tank	Add fuel
	• Fuel filters plugged	Change filters
	• Air in the fuel system	Find and repair the cause and prime the fuel system
	• Air intake dump valves tripped	Manually reset valves
	• Low coolant level	Add coolant
	• No power to the PEEC panel	Turn the ECB on and off to reset the PEEC panel
	• Engine Diagnostic Panel showing box fault	Refer to Chapter 4
Misfiring or running rough	Low fuel pressure. Fuel must be at 40 psi at full load.	
	• Fuel filters plugged	Change filters
	• Air in the fuel system	Repair suction leak and prime the fuel system
	• Valve clearance incorrect	Adjust valve clearance

Problem	Probable Cause	Suggested Corrections
Misfiring or running rough (cont.)	• Fuel injector seized	Change fuel injectors
	• Leak or break in the fuel line between fuel manifold and cylinder head	Install new line
Engine shuts down shortly after start up	• No output from the auxillary generator	Check battery charging circuit
	• Low oil pressure	See Problem - Misfiring or running rough
	• Low vent air pressure	Repair blower fan
	• Vent air pressure switch defective	Replace switch
Engine vibrating excessively	• Engine mounting bolt loose	Retorque all mounting bolts
	• Driving equipment is misaligned or out of balance	Correct alignment or balance
	• Misfiring or running rough	See Problem - Misfiring or running rough
Excessive black or gray smoke	Not enough air for combustion	
	• Intake filters plugged	Change filters
	• Faulty turbo charger	Change turbo charger
	• Wrong fuel injector timing	Adjust timing

Problem	Probable Cause	Suggested Corrections
Excessive black or gray smoke (cont.)	• Faulty fuel injectors • Too much load on the engine • One of the two intake air dump valves tripped	Change injectors Check excitation Reset valves
Excessive white or blue smoke	• Too much oil in the crank case • Worn piston rings • Turbo charger oil seal defective	Remove extra oil Major overhaul Change turbo charger
Low loading (minimum loading)	Subtle wheel slip • Wet rails • Defective wheel slip system • Defective traction motor, pinion, cabling or power contacts	 Apply sand Qualify the wheel slip system Cut out defective traction motor
No power (engine not loading)	Generator field contactor not picking up • Generator field switch defective • Ground switch on OUT	

Problem	Probable Cause	Suggested Corrections
No power (cont.)	• Defective wheel slip panel • Subtle wheel slip • High voltage grounds	Change panel See Problem - Low loading See Problem - High voltage grounds
Excessive wheel slip	• No sand • Wet rails • Mismatched wheels • Heavy train	Add sand Apply sand Change smaller wheels Reduce train
Continuous wheel slip	• Spun pinion • Seized pinion • Power contactor not closing	Isolate defective motor. Consult Mechanical Rep. before moving the train. Stop the train. Consult Mechanical Rep. before moving the traing Make necessary repairs
Low horsepower	• Bad quality fuel • Low fuel pressure • Fuel injectors seized	Remove bad fuel from tank, change fuel filter and flush the system Make sure the pressure is at least 40 psi at full load Change injectors

Problem	Probable Cause	Suggested Corrections
Low horsepower (cont.)	• Low booster pressure because:	
	- air cleaner and exhaust system are restricted	Clear air cleaner and exhaust system
	- air dump valves are partially closed	Manually reset valves
	• Governor linkage out of adjustment	Adjust governor linkage
	• Turbo charger has carbon deposit	Repair turbo chargers as necessary
	• Rack sensor hung-up or out of adjustment	Replace or adjust rack sensor
	• Defective Derate Panel	Repair or replace Derate Panel
No Dynamic Brake	• Dynamic Brake set-up failure	Check DBO, BKT, BKR1,2, SH, DMR, RH
	• Dynamic Brake excitation failure due to:	
	- traction alternator current and voltage sensor fault	Replace or repair scaling network or wire harness
	- GF drop out if DB blower's current falls outside a window of operation	Check DB blower and wheel slip system

Problem	Probable Cause	Suggested Corrections
Low oil pressure	• Plugged oil filters	Change filters if filter differential gauge reads over 15 psig
	• Diesel fuel in lubrication oil	Find cause and make necessary repairs
	• Oil cooler plugged	Change oil cooler
	• Faulty oil pump	Change oil pump
Coolant in oil cooler	• Faulty oil cooler	Change oil cooler
	• Faulty cylinder head gasket	Change gasket
	• Cylinder head cracked	Replace cylinder head
	• Crack in cylinder block	Repair or replace cylinder block
	• Defective inner seal	Change inner seal
Oil in cooling system	• Faulty oil cooler	Change oil cooler
	• Faulty cylinder head gasket	Change gasket
Engine running hot	• Low coolant	Add coolant
	• Engine thermostat stuck closed	Change thermostat
	• Low or high temp-erature switches OFF	Move switches to AUTO
	• Low or high fan cut-in thermostat defective	Change thermostat. Move temp. test switches to MANUAL to verify.

Problem	Probable Cause	Suggested Corrections
Engine running hot (continued)	• Blown rad. fan fuse	Replace fuses
	• Defective interlock or coil on FC1 or FC2 contactor	Make necessary repairs
	• No output from the auxilliary alternator	Make necessary repairs
	• Faulty rad. fan motor	Replace motor
	• Fan rotation reversed	Correct rotation
	• Radiators plugged from the inside	Replace radiators
No battery charge	• XAFB tripped or OFF	Reset breaker
	• Voltage Regulator fuse blown	Replace fuse
	• Tickler failure	Check tickler circuit
	• Defective BN or BX card in Voltage Regulator	Replace defective card
	• Faulty aux. alternator	Replace alternator
Compressor not pumping air	• Comp. test switch OFF	Move switch to AUTO
	• Comp. control breaker tripped	Reset
	• No oil pressure	Find cause and make necessary repairs
	• CCS defective/needs adjustment	Adjust or replace switch

Problem	Probable Cause	Suggested Corrections
Compressor not pumping air (cont.)	• Compressor contactors CC1 and CC2 not working together reliably	Move Compressor Test Switch to MANUAL and notify Mechanical Shops.
	• Compressor magnet valve defective	Replace magnet valve
Compressor pumping air continuously	• Compressor control switch (CCS) is defective or needs adjustment	Adjust or change CCS
	• Compressor magnet valve defective	Change magnet valve
	• Air line from magnet valve to compressor unloader valve restricted	Clean or replace air line
	• Compressor valve stuck open	Change unloader valve
Slug unit fails to operate	• SXPR breaker is OFF	Reset breaker
	• No vent air pressure	Find cause and make necessary repairs
	• No trainline signal to the slug unit	Find cause and make necessary repairs

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